NOV
5516
.b

Bound 1946

HARVARD UNIVERSITY

VE RI TAS

LIBRARY

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

Exchange
6253

THE

Proceedings

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOLUME XX, PARTS 1-2-3-4.

SESSIONS 1938-1942

HALIFAX

6253

Museum of Com
Zoolog
JAN 25 1943
LIBRAR

CONTENTS

(Vol. XX, 1938-1942)

1938-39

Pneumothorax Gases. C. B. Weld 1
Some Marine Fish and Salp Records. R. A. MacKenzie 13
Presidential Address. G. H. Henderson 21
Proceedings of Meetings. Session 1938-39 27
Abstracts. (Papers read before the Institute but not published in the Proceedings) 30

1939-40

A Preliminary List of the Fishes of Malpeque Bay. A. W. H. Needler 33
Some Marine Records from Nova Scotian Fishing Waters. R. A. McKenzie 42
Presidential Address. Harold S. King 47
Proceedings of Meetings. Session 1939-40 50
Abstracts. (Papers read before the Institute but not published in the Proceedings) 53

1940-41

Barytes Deposit at Pembroke, N. S. A. E. Cameron 57
The Ferns of Nova Scotia. A. E. Roland 64
The Ascorbic Acid Content of Some Maritime Province Foods. B. C. Collier, M. F. M. Morrison and M. E. Morse 121
Some Recent Aspects of Genetics. R. R. Gates 127
Presidential Address. Harold S. King 141
Proceedings of Meetings. Session 1940-41 149
Abstracts. (Papers read before the Institute but not published in the Proceedings) 153

1941-42

Additions to the List of Odonata of the Maritime Provinces. E. M. Walker 159
The Grasses of Nova Scotia. W. G. Dore and A. E. Roland 177
Presidential Address. R. J. Bean 289
Proceedings of Meetings. Session 1941-42 293
Abstracts. (Papers read before the Institute but not published in the Proceedings) 297
Index to Vol. XX 302

Museum of Comparative Zoology
NOV 2 1939
LIBRARY

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOL. XX. 1938-1939 PART 1

CONTENTS

Pneumothorax Gases C. B. Weld 1
Some Marine Fish and Salp Records. R. A. McKenzie 13
Presidential Address. G. H. Henderson 21
Proceedings of Meetings. Session of 1938-39 27
Abstracts. (Papers read before the Institute but not published in the Proceedings.) 30

Editor: Harold S. King.
Editorial Board: E. G. Young, E. Hess and G. H. Henderson.
Printed for the Institute by Imperial Publishing Co., Ltd.
Date of Publication: September 30, 1939.

Museum of Comparative Zoology
NOV 2 1939
LIBRARY

6253

PROCEEDINGS
OF THE
Nova Scotian Institute of Science

SESSION OF 1938-9
(Vol. XX, Part 1)

PNEUMOTHORAX GASES.

C. B. Weld.
Department of Physiology, Dalhousie University,
Halifax, N. S.

(Received June 12, 1939).

ABSTRACT.

Analyses of the gas mixtures from 15 pneumothoraces in dogs and from 62 human patients reveal a striking difference between the human and dog results. The human patients as a rule have a much lower concentration of oxygen and a somewhat higher concentration of carbon dioxide than do the dogs.

Possible reasons for this divergence are discussed and attempts have been made with dogs to bring their results into line with human figures. The duration of the pneumothorax is not a factor. A large pneumothorax may result in a slight change in the analysis in this direction, as may depression of respiration by morphine, but these are not the chief factors. Results in dogs approximating human analyses are obtained when pleural irritation and inflammation is induced.

The typical composition of a human pneumothorax is therefore apparently due to a concomitant pleural inflammation.

Introduction.

The induction of an "artificial pneumothorax" is now a common practice in the treatment of certain forms of lung disease such as pulmonary tuberculosis, and the occurrence of a "spontaneous pneumothorax" is not an uncommon development of these same diseases. The term pneumothorax means merely the presence of gas in the pleural cavity, that is, within the chest but outside the lungs, and unless qualified its full significance is not indicated.

If the pneumothorax is artificially induced, care is taken to avoid infection of the pleura or lining of the pleural cavity, and the air put in displaces the lung thereby allowing it to shrink or collapse and putting it at rest. If the pneumothorax is of spontaneous origin, the usual cause is a small tear of the surface of the lung, opening into the smaller branch bronchi and allowing air to enter the pleural cavity through the respiratory tubes. The effect towards collapse of the lung would be the same, but as the trachea and bronchi are by no means always bacteriologically sterile, infection of the pleural surface with later development of pleurisy and perhaps empyema is only too likely to result. A spontaneous pneumothorax may develop in a person who already has an artificial and the desirability of knowing when this has happened is apparent. Sometimes it cannot be detected by ordinary clinical examination. The primary purpose of this work was to provide a test which would aid the clinician in his diagnosis. Partial success has been noted in this regard, but these more clinical features are not being discussed in this paper. In the course of the work certain results presented themselves for explanation, and the further investigation of these results constitute the bulk of this publication which really is a preliminary report of work still in hand.

Pneumothorax in Dogs and Humans.

Air is injected into the pleural cavities by a syringe with an attached hypodermic needle inserted through the thoracic wall. The amount injected varies from about 100 cc. to 500 c.c. This is all absorbed from the cavity within a day or two unless air is repeatedly injected and, when this is done, the absorption rate apparently becomes slower after a time. The total gas pressure within the pleural cavity is subatmospheric, being in the order of -10 to -20 mm. Hg during inspiration and 0 to -10 mm. Hg during expiration.

This gas is in a closed cavity the walls of which are moist so that the components of the mixture (O_2, CO_2, and N_2) will presumably go into solution in the fluid of the pleural surfaces according to their partial pressures. The pleural and thoracic walls behind them contain circulating blood which is also carrying these gases. If air is injected, one would expect oxygen to be absorbed through the pleura and carried away by the blood as the O_2 tension of the blood is less than that of the injected air. Similarly as the CO_2 tension of the blood is greater than the negligible value for the injected air, one would expect carbon dioxide to diffuse out from the blood into the pleural cavity. In time the gases in the cavity should reach or at least approach an equilibrium with the tensions of the blood. Equilibrium would appear to be attained (Table 6) in the case of CO_2 in less than 30 minutes but in the case of O_2 not for 8 to 12 hours.

The pressures of the gases in the pleural cavity are readily determined by analysis in the ordinary Haldane apparatus. Thus if 10% of the gas is O_2 then the pressure of O_2 would be of the order of,

$$\frac{10}{100} \times (745\text{-}45) = 70 \text{ mm. Hg.} \qquad \begin{matrix}(745 = \text{total gas pressure}) \\ (\ 45 = \text{tension aqueous vapor})\end{matrix}$$

The tensions in the blood cannot be accurately obtained as it is the capillary blood in the pleura (parietal and visceral) which is significant. The gas tensions of capillary blood will lie somewhere between those of the arterial and venous bloods supplying and draining the region. However an attempt has been made below to calculate probable values (Table 1). Arterial and mixed venous blood tension figures are given,

TABLE 1.

Blood Gases.

	Tension	See Text
	(mm. Hg.)	%
Oxygen—Normal Arterial	90	13
Normal Venous	40	6
Very low Venous	20	3
CO_2 —Low Arterial	35	5
Normal Venous	46	6.5
Very High Venous	56	8
Maximum Endurable	70	10

and in the second column the percentage figures represent the analysis of pleural gas which would approximate these tensions.

A consideration of these figures leads to the conclusion that the pneumothorax gas if in equilibrium with capillary blood should ordinarily consist of about 8-10% O_2 and about 5.5-6.5% CO_2. The figures actually obtained are given in Table 2, in which the means of analyses of gases of 15 separate pneumothoraces induced in normal dogs, the standard deviation of the means and the extreme range of figures are given. Also given is the distribution of the 62 human pneumothorax cases according to their analysis figures.

TABLE 2.

Pleural Gases.

Dogs		Humans			
Mean	Range	$\%O_2$	Cases	$\%CO_2$	Cases
$\%CO_2$ 5.8±0.2	5.0- 6.6	0- 2.9	20	7.1 up	22
$\%O_2$ 10.2±0.3	8.4-12.5	3- 4.9	27	7-5	33
		5-10.0	9	4.9-0	7
		10.1 up	6		

The figures show that the results in the dogs conform very closely to the predicted values but that a great divergence is observed in the human results. About $\frac{3}{4}$ of the human cases showed an O_2 concentration of less than 5% and indeed less than 1% was the value for several. About $\frac{1}{2}$ of the cases, too, showed a higher CO_2 percentage than did any of the dogs. These results conform to those reported from time to time since 1823. In the more recent literature[1-6], the workers have for the most part been interested in the clinical application of the results or have reported them incidental to other work,

---

[1] Davy, *Phil. Trans.*, 1823, p. 496.

[2] Demarquay and Leconte, *Compt. rend de l'acad. sc.*, Vol. 56, (1860).

[3] Rist and Strohl, *Annals de Med.*, 8, 233, (1920).

[4] L. Hill and J. A. Campbell, *Brit. Med. Journal*, 1, 752, (1923).

[5] J. A. Campbell, J. Physiol, 57, 273, (1923).

[6] P. N. Coryllos, H. Konterwitz and E. R. Levine, *Am. Rev. Tbc.*, 26, 153, (1932).

without explanation. Possible causes of these divergences of the human figures from the predicted composition seemed well worthy of investigation.

One might ask at this point what differences in conditions, if any, may be present in these two series which could possibly tend to cause these results. Some at least of the human cases with high O_2 concentrations are those with spontaneous or open pneumothoraces; these also have a low CO_2 concentration. Those cases with the low O_2 concentrations, usually also with high CO_2 figures, are of particular interest in that they are more difficult to explain.

Duration of the Pneumothorax.

The human figures as a whole are not strictly comparable to the dog figures in that the dogs were normal animals and the humans were patients under treatment. Some were ill, some were apparently well, but all were breathing normally and none showed any signs of respiratory difficulty. They had had pneumothoraces for a considerable time, years in some cases. Specimens for analysis were taken when they came in for a routine refill, which ranged from a few days to a month or more from the last refill. The dogs on the other hand had pneumothoraces of relatively short duration, a week or so, and they required refilling every day or two in order to keep gas in the pleural space. Analysis figures of dogs, unless otherwise indicated, are of specimens taken 24 hours after injection of air. However, the duration of the pneumothorax does not seem to be responsible for the difference between the animal and human figures. In two dogs, pneumothoraces were maintained continuously for two months and throughout this period the analysis remained constant. There was no tendency with time for the O_2 figures to become lower or for the CO_2 concentrations to rise. Furthermore consideration of the few figures obtainable of human cases early in the course of a pneumothorax failed to show any correlation between duration of pneumothorax and the analysis results.

THE DEGREE OF OXYGENATION OF ARTERIAL BLOOD.

The possibility arises that with a considerable degree of collapse of lung consequent upon a pneumothorax, the gaseous exchanges between lung and blood would be sufficiently impaired to cause low O_2 and high CO_2 tensions in the arterial, and hence capillary, blood. That this is not so in the ordinary human cases such as those being reported is well established[7]. In our dogs on eight occasions the oxygen content and oxygen capacity of arterial and venous bloods have been determined. The bloods were taken by cardiac puncture and the determinations done with the Haldane Blood Gas apparatus. By referring these figures to a standard oxygen dissociation curve[8] the oxygen tensions were estimated. It must be stressed that the oxygen tensions as estimated by this method must be very inaccurate and can only give a rough approximation of the true value. The arterial oxygen tensions averaged 70 mm. Hg and the venous 32 mm. Hg. Typical normal figures are 90 and 40 mm. Hg respectively so these figures do suggest a somewhat lowered oxygen tension. However it is to be noted that the tensions of oxygen in the pleural spaces of these dogs lay in every case between the arterial and venous figures.

A different approach to this question has been used also. After induction of a large pneumothorax, specimens were taken for analysis during the period of absorption. Dogs which had had a moderate pneumothorax for some time were chosen, so that the absorption rate would not be too rapid. 600-1000 c.c. air were injected, and absorption was not complete for about a week.

A typical example is given in Table 3.

A slight rise in oxygen concentration and slight fall in carbon dioxide concentration with the diminution of the pneumothorax is noted and was similarly noted in six of the seven trials. The change however is slight and would seem to be far too small to account for the great difference between the animal and human figures. This is especially true when it is remembered that specimens from the human cases were taken when they had come in for a refill and X-ray observations made at the time frequently showed a considerable degree of re-expansion of the lung to be present.

---

[7] J. C. Meakins, "*Practice of Medicine*", C. V. Mosby, 1936.

[8] Peters, J. P. and Van Slyke, D.D., "*Quantitative Clinical Chemistry*", Vol. 1. Williams and Wilkins 1932.

TABLE 3.

	Composition of gas in pleural cavity	
Days from induction	% O_2	% CO_2
2	8.6	6.0
5	9.5	5.5
8	10.0	4.9

An attempt was also made to depress respiration in two dogs by keeping them for several days continuously under the influence of morphine. It was thought that this might reduce the degree of oxygenation of the arterial blood and hence cause a lowered oxygen concentration in the pneumothorax. The results are given in Table 4. Sufficient morphine was given daily to keep the animals in a lethargic condition.

TABLE 4.

Dog A					Dog B.			
Control		Morphine			Control		Morphine	
%O_2	%CO_2	%O_2	%CO_2		%O_2	%CO_2	%O_2	%CO_2
10.2	5.5	8.1	8.5		11.2	6.0	8.4	7.7
9.4	6.6	9.0	7.7		10.2	6.0	8.0	8.3
9.1	6.1	9.5	6.0		10.4	6.5	9.3	6.4
9.0	6.6	8.8	6.7		9.3	6.6	7.8	7.5
9.5	6.3	...	...		....	...	...	...
10.7	5.6	...	...		....	...	...	...
9.6	6.1	8.9	7.2	Averages	10.3	6.3	8.4	7.5

The control figures consist of all the ordinary pneumothorax analyses made on the dog in question and the morphine figures are those obtained during four days of morphine.

It will be seen from these figures that there does seem to be some reduction in the oxygen concentration in the pneumothorax gases following the administration of morphine. The change however is relatively slight and is not nearly enough to bring the dog figures into line with the human analyses.

The State of the Pleura.

As the duration of the pneumothorax, or a defective gaseous exchange between the alveoli and the blood do not account for the unexpectedly low oxygen or high carbon dioxide concentration of the pleural gases in human cases, some possible change in the state of the pleural membranes must be considered as a possible cause.

Coryllos[9] has reported that a pneumothorax analysis of less than 1% O_2 will be found in cases of empyema, if between 1 and 2% O_2 are found a non purulent fluid will be present and that if more than 3% O_2 is present the case is a simple pneumothorax. In our series it is certainly true that most of the lowest figures are found in empyema cases but no such sharp differentiation as Coryllos suggests was found. For example four cases with no demonstrable pus in the pleural cavities gave analyses of less than 1% oxygen, and on the other hand, five cases with pus gave analyses of more than 3% oxygen.

Severe pleural irritation has been induced in three dogs by the injection of 1-2 cc. of Monsel's solution (Ferric Subsulphate) and in one dog by the injection of 1 cc. of 5% solution of iodine in 10% potassium iodide. The injection material in each case was diluted to 20-30 cc. with saline. The injections are transiently very painful and morphine or an anaesthetic must be given with the injection. Following the injection there is a small effusion of clear pleural fluid, the composition of the pleural gas mixture changes over a period of several days, and the rate at which the pneumothorax is absorbed becomes very much slower. Gas may remain in the pleural cavity for weeks without need for refilling. Analysis of this gas is given in Table 5. Specimens for these analyses were taken 3-5 days after injection of irritant solution and air.

---

[9] Coryllos, P. N., *J. Thorac. Surg.*, 7, 48, (1937).

TABLE 5.

Material Injected	Pneumothorax Analysis	
	% O_2	% CO_2
Ferric Subsulphate	4.0	7.8
" "	4.8	8.9
" "	2.6	7.4
Iodine	5.8	7.9

These are the first results of this type of experiment and it is this work which is now being subjected to further investigation. However the figures are of great interest in that the figures are of the same order as those from human cases. It seems to be significant that the only cases of pneumothoraces in dogs that have given analyses comparable to those of the majority of human cases are those in which pleural irritation was present. If the pleural inflammation were merely acting so as to delay the diffusion of gases through the membrane, equilibration of the pleural gases with the blood would be delayed perhaps but equilibrium should eventually be attained at the normal levels. A thickening of the pleurae and an outpouring of pleural fluid, both of which occur, would reasonably account for this. Equilibrium is however attained in a reasonably normal time but at a different level than that commonly found.

That this is true, is shown by the following figures. In Table 6 are grouped the results of "normal" animals and a "pleurisy" animal which had had Monsel's solution injected. As is seen from the figures, after the injection of air or nitrogen into the pleural space, specimens were taken at intervals and analysed. The "normal" results are each compiled from four curves. The final levels in the four animals were not exactly the same, nor were the intervals, so that the figures given are not averages but are typical figures. The figures for the "pleurisy" animal are the actual results in a single animal obtained nine days after the first injection of irritant. In this case it was known (Table 5) that following the injection of air, oxygen would be absorbed until a concentration of about 5% is reached. It was desired to find out whether oxygen would also pass in the reverse direction, from blood into pleural cavity, and hence for the purposes of this experiment nitrogen was used. The nitrogen was obtained from a cylinder and as actually injected contained about 2% oxygen.

TABLE 6.

Equilibration Curves of Pneumothoraces.

Normal Animals (4)					Pleurisy Animal		
	Air		Nitrogen		Nitrogen		
Time since induction	CO_2	O_2	CO_2	O_2	Time since induction	CO_2	O_2
0 min....	1.5%	20.0%	1.5%	2.5%	0 min.	2.1%	2.4%
10 " ...	4.5	19.0	4.5	3.0	5 "	5.0	2.4
30 " ...	6.0	17.0	6.0	5.0	15 "	6.9	2.5
1 hour...	6.0	15.5	6.0	6.5	1 hour	7.6	3.0
3 " ...	6.0	13.0	6.0	7.5	3 "	7.8	4.0
6 " ...	6.0	11.0	6.0	8.5	6 "	...	...
1 day....	6.0	10.0	6.0	10.0	1 day	8.1	5.0
2 days...	6.0	10.0	6.0	10.0	2 days	8.0	4.8

Thus it is clear that both in "normal" and "pleurisy" dogs, if air is injected into the pleural cavity, oxygen is removed presumably into the blood and carbon dioxide enters the cavity presumably from the blood. If nitrogen is injected, both carbon dioxide and oxygen diffuse into the cavity and the ultimate gas concentrations are the same no matter whether air or nitrogen is injected. This certainly suggests that the pleural gas is equilibrating with blood gases. In the case of the pleurisy dog the final concentration for oxygen is lower and for carbon dioxide it is higher, and the rate of the attaining of the equilibrium is not greatly delayed.

A similar curve made two months later in the same dog revealed that equilibrium was not attained with CO_2 for 1-3 hours and with O_2 for 24-48 hours. At this time the pleura was a thick tough fibrous layer 2 mm. thick instead of the normal gossamer thin membrane. Even though there is now obvious delay in the equilibration process, it is apparently complete in a relatively short period while the total removal of all gases from the cavity is not complete for a matter of weeks. Coryllos and Birnbaum[10] have reported that the absorption of nitrogen, hydrogen, or helium from a pleural cavity or an obstructed pulmonary lobe is very much slower than the absorption of oxygen or carbon dioxide. This observation is in keeping with our findings as the complete absorption of the pleural gases would be controlled by the absorption rate of the nitrogen present while equilibrium with regard to O_2 and CO_2 would be much more rapidly attained.

Two hypotheses are being used as guides for further work in this problem. The first is that the inflammatory condition has markedly altered the capillary circulation of the pleural surfaces in such a way that the capillaries contain a more poorly oxygenated or more greatly reduced blood than is usual. Some degree of stagnation or stasis of the blood in the capillaries would cause this and is quite within reason. Possibly the best indication of this is the analysis of pleural gases but some other means of approach, possibly histological, will be needed for proof. The second is that the pleural fluid, purulent or not, and/or the thickened pleura utilises oxygen which is partially at least obtained from the pleural gases. Against this conception is the demonstration that even in these cases oxygen diffuses into the pleural cavity if pneumothorax is induced with nitrogen. Only one experiment has been performed to directly attack this problem. About 100 cc. purulent fluid from a human case was placed in a closed vessel with about

---

[10] Coryllos, P. N. and Birnbanm, G. L., *Am. J. Med. Sc., 1932*, 183, Pp. 317, 326, 347.

50 c.c. air and this was shaken from time to time and left for three days at room temperature. On analysis the air then contained 2.0% CO_2 and 17.9% O_2. This does suggest some respiratory activity of the purulent fluid. Its significance would seem to be small but can hardly be judged on the basis of this one determination.

Conclusions.

The gas mixture in a pneumothorax rapidly reaches an equilibrium and its composition depends upon the individual. In most dogs it is about 6% CO_2 and about 10% O_2 while the figures in human cases vary widely; in the majority it is less than 5% O_2 and in many, less than 1% O_2, with more than 7% CO_2.

Pleural inflammation in dogs causes the composition of their pleural gases to become similar to human figures.

A pneumothorax with a low oxygen and high carbon dioxide concentration is indicative of pleural inflammation.

SOME MARINE FISH AND SALP RECORDS*.

R. A. McKenzie.

Atlantic Biological Station, St. Andrews, N. B.

(Received July 10, 1939).

ABSTRACT.

This paper records information mainly on the abundance or occurrence of nineteen species of uncommon Canadian Maritime marine fish. The distribution, as far as could be learned, of *Salpa* (*Jasis*) *zonaria* during the years 1937 and 1938 in Nova Scotian and adjacent waters because of its hydrographic significance, is also given, together with some observations on its habits.

INTRODUCTION.

In recording the following notes regarding some of our marine fauna, it is hoped that the information may prove useful, if not at present, then in the future to those who may be interested in the distribution, abundance and life history of various forms of marine life as it is at present.

Many thanks are due, especially to Professor J. R. Dymond, Mr. J. T. Nichols and Mr. William C. Schroeder for their kindness on many occasions in checking identifications and making comparisons with museum specimens.

FISHES.

Sphyrna zygaena (Linnaeus) 1758. Hammerhead Shark.

A specimen of this shark was taken in a trap off Sambro Light, Halifax County, August 25, 1938. As in the case of the other definite record[1] of the capture of this species in our waters, this specimen was small, 53 cm.

However, there is a report, fairly well confirmed but lacking details, that a large, full size specimen was taken years ago in the vicinity of Brier Island, Nova Scotia, in the Bay of Fundy.

Bigelow and Schroeder[2] record the capture of a 12-foot specimen in the Fundian Channel in August 1928.

---

*This paper is published with permission of the Fisheries Research Board of Canada.

[1] Vladykov—*Proc. N. S. Inst. Sci.*, vol. 19, Pt. I, pp. 1-18, 1934-1935 (1935).

[2] Bigelow and Schroeder—*Bull. U. S. Bur. of Fish.*, vol. 48, (1936).

Alopias vulpinus (Bonnaterre) 1788. Thresher Shark.

On August 28, 1936, a specimen of this shark 4.8 metres (16 feet) in length was taken in a weir at Deer Island, New Brunswick, in the Bay of Fundy.

Cetorhinus maximus (Gunner) 1765. Basking Shark.

Previously there have been no positive records of the capture of this species in the Nova Scotian area, though it has no doubt been taken.

During the summer of 1934 an 8.7 metre (29 foot) specimen was caught in a herring net at Whale Cove, Grand Manan, N. B.

On August 4, 1936, a specimen of this shark was caught in a weir at Back Bay, New Brunswick, in the Bay of Fundy. It measured 8.4 metres (28 feet) in length.

During July 1937, another specimen 3.4 metres (11 feet 4 inches) in length was taken at the mouth of the LaHave River, near Lunenburg, Nova Scotia.

On September 7, 1938, still another specimen was found dead in a mackerel trap at French Village, St. Margaret's Bay, Nova Scotia. This one measured 7.3 metres (24.5 feet) in length.

Using the graph given by Schultz[3] these sharks should have weighed about 10,700 lb., 10,000 lb., 300 lb. and 6,600 lb., respectively.

Psychichthys affinis (Capello) 1868. Short-finned Chimaera.

A 126.25 cm. (4 foot 2.5 inch) specimen was taken on October 15, 1930, by the United States trawler Oretha Spinney in the vicinity of Browns Bank (240 miles ESE of Gloucester, Mass.) and has been recorded by MacCoy[4].

Notacanthus phasganorus Goode 1880. Sword-tail Eel.

This eel was found in our waters 20 miles south of Sable Island in 100 fathoms on February 10, 1935, by a United States trawler and its occurrence has been recorded by Bigelow and Schroeder. It was 106.25 cm. (42.5 inches) in length[5].

---

[3] Schultz—*Jour. Mammology*, vol. 19, no. 4, November 14, pp. 480-487, (1938).

[4] MacCoy—*Bull. Bost. Soc. Nat. Hist.*, no. 58, (Jan. 1931).

[5] Bigelow and Schroeder—*Proc. Boston Soc. of Nat. Hist.*, vol 41, no. 2, pp. 13-18, (June 1935).

Etrumeus teres (DeKay) 1842. Round Herring.

This elongate herring, with a rounded, not sharp-edged, belly as in other herring, is rarely found north of Cape Cod. However, in September 1937, possibly because of unusually high water temperatures, quite a number were taken in a weir at Herring Cove, Campobello Island, N. B., in the Bay of Fundy, and their occurrence has been recorded by Leim.[6] This constitutes the first record of their capture in Canadian Maritime waters.

Alosa sapidissima (Wilson) 1811. Shad.

On May 4-9, 1937, the S. T. Viernoe caught eight large shad on the northern edge of Middle Ground, Lat. 44° 45′ N., Long. 60° 40′ W. in 23-30 fathoms. This location is some 35-40 miles directly offshore from Canso. This capture supplies a little further information to show that these fish winter in the offshore waters, especially in this Middle Bank region[7].

Argentina silus Ascanius 1763. Argentine.

On two trips of the S. T. Venosta to the region immediately west to southwest of Emerald Bank during March 1938, Wilfred Dorry reported that "bucketsful" of these fishes were brought on deck on a number of occasions. The specimen saved was 22 cm. in length.

They were mistaken for and almost eaten as smelts by the finders. This is the fourth record[8] of this species in our waters and the only time they have been taken in any quantity, though Firth[9] reports thousands of pounds being taken on occasion in the Cape Cod to Georges Bank region.

Chauliodus sloanei Bloch and Schneider 1801. Viperfish.

A specimen of this species was taken from the stomach of a swordfish caught in the gulley between Browns and Georges Banks in 1931. It was recorded by Bigelow and Schroeder[2].

---

[6] Leim—*Fish. Res. Brd. Can., Prog. Rept. Atlantic*, no. 21, p. 5, (Dec. 1937).

[7] Vladykov—*Copeia*, Nov. 15, no. 3, p. 168 (1936).

[8] McKenzie and Homans—*Proc. N. S. Inst. of Sci.*, vol. 19, Pt. III, pp. 277-281, ·1936-37 (1938).

Firth—*Bull. Boston Soc. Nat. Hist.*, no. 61, pp. 8-14, (Oct. 1931).

Macrourus bairdii (Goode and Bean) 1895. Common Rat-tail.

These inhabitants of the muddy bottom in the deeper waters around the offshore banks are brought up occasionally during the winter—possibly a dozen per trawler per winter, according to the fishermen's reports—as fishing is carried on there only at this season.

Two specimens caught in 80-100 fathoms inside of "Western Bank" were brought in by Wilfred Dorry, S. T. Venosta, March 8-20, 1938. Again on January 30, 1939, this man brought in two more, 32.5 cm. and 23 cm. in length, from 80 fathoms depth 35 miles west of Middle Ground, approximately Lat. 44° 25′ N., Long. 61° 30′ W.

Sarda sarda (Bloch) 1793. Common Bonito.

Around St. Margaret's Bay, Nova Scotia, it is commonly reported that the Bonito occurs in fair numbers in the mackerel schools during certain years. However, definite records of the capture of this species in our waters previously are scarce[1].

On October 15, 1937, Mr. Lama Briand caught a specimen off Samsonville, St. Peter Inlet, Bras D'Or Lake, Cape Breton, Nova Scotia. This location is but a short distance from the inner end of St. Peter canal into this lake. The specimen was 37 cm. long.

During August and September 1938, many of these fish were taken in the mackerel traps in the vicinity of Lunenburg, Nova Scotia, and quite a number of them varying in length from 20-40 cms. were on exhibit at the Lunenburg Fisheries Exhibition in September of that year.

Makaira albida (Poey) 1861. Spearfish or Marlin.

Specimens of this southern fish have been taken in recent years by other than Canadian fishermen in the vicinity of Browns and Sable Island Banks. The capture of these specimens was mentioned in the report by Bigelow and Schroeder in 1936.[2]

Poronotus triacanthus (Peck) 1800. Dollarfish or Butterfish.

This fish, while a summer visitor to our waters from the south, shows considerable variation in the numbers present in various years.

About twenty-five years ago (1910-1913) in St. Mary Bay, Nova Scotia, there were years when these fishes were taken from the weirs in such abundance that they were canned—though not commercially—at St. Bernard and Grosses Coques during September to November. Not until 1938 have they been present in such abundance again.

In Halifax Harbour there are usually fair quantities found during the summer and autumn. However, in the autumn of 1938, they were exceptionally abundant (paralleling their return in quantity to St. Mary Bay no doubt); an estimated 15,000 lb. or 6,750 kg. were dumped out of two traps on November 12. These fish were from 10 cm. to 18 cm. in length.

Cyclopterus lumpus Linnaeus 1758. Lumpfish.

On September 4, 1936, a 9.6 cm. (3.8 inch) specimen was taken from Carson's weir, St. Andrews, New Brunswick, and placed in the salt water tanks at the Atlantic Biological Station along with some young pollock and cod. It was fed chopped clams and herring about thrice weekly along with the other fish. However, while the other fish were fed to capacity each time, one usually tired of preparing food for the Lumpfish before its capacity was reached. Consequently it cannot be said that this fish had absolutely all it could eat. Nevertheless, on September 13, 1937, at death, this Lumpfish was 30 cm. (12 inches) long and 714 gm. in weight. Such growth is phenomenal.

According to Bigelow and Welsh[10] this specimen was possibly in its third summer when captured, for they indicate the length in the second summer to be 50-74 mm., in the third summer 95-110 mm. and in the fifth summer 260 mm. Thus our specimen in growing from 96 mm. to 300 mm. put on, in one year, the growth that in nature is supposed to require two or even three years.

Since these fishes are not very fast or agile swimmers, especially as they grow larger, it is believed that they wait[11] for a good portion of their food to come to them, rather than vice versa. Hence, they may never have all the food they can take, and in this case such prodigious growth should probably not be considered surprising under the circumstances.

---

[10] Bigelow and Welsh—*Bull. U. S. Bur. Fish.*, 40, Pt. I, 567 pp., (1925).

[11] Jenkins—*The Fishes of the British Isles* London, 1925, 406 pp.

Remora remora (Linnaeus) 1758. Blue Sharksucker.

On October 7, 1937, the S. T. Viernoe brought in a specimen 16.7 cm. in length taken from a small but unidentified shark on the NW part of St. Pierre Bank. This makes two records for the outer coast of Nova Scotia and two during the last few years for St. Pierre Bank.[8]

Ulvaria subbifurcata (Storer) 1839. Radiated Shanny.

A specimen 46 mm. long was taken in a young fish trawl on June 27, 1938, by M. V. Zoarces in Shad Bay, Halifax County, Nova Scotia, in the depth range of 2-9 fathoms. This is only the third record[12] for this species in our area, though it is rather common and widely distributed in the Gulf of Maine.[2]

Anarhichas minor Olafsen 1774. Leopardfish.

During the last few years[8] about half a dozen of these fishes have been reported each year.

Captain Moser of the schooner Cachelot III brought in a 130 cm. specimen of this species from 54 fathoms on eastern Banquereau, Lat. 44° 50′ N., Long. 57° 27′ W., on April 13, 1937.

This same Captain caught three more unmeasured specimens from this same general area on October 16, 1937, and the schooner I. E. Spindler caught two more, 135 cm. and 126 cm. in this region on December 2, 1937.

Balistes capriscus Gmelin 1788. Triggerfish.

On August 11, 1937, Mr. E. D. Ridgley brought in a specimen taken alive on the shore of McNabs Island, Halifax Harbour. It was 29 cm. in length and 675 gm. in weight.

This is the fourth record[1] of a capture in the waters of our area.

---

[12] Hachey—*Fish. Res. Brd. Can. Prog. Rept. Atlantic* no. 23 pp. 13-14 (Nov., 1938).

Alutera schoepfii (Walbaum) 1792. Orange Filefish.

A specimen 9.7 cm. long was found at Herring Cove, Halifax Harbour, August 25, 1938. Due to decomposition the above identification may be taken with some reservation. Of this specimen, Mr. J. T. Nichols, American Museum of Natural History, writes "very likely an *Alutera schoepfii* (Walbaum)—(but) I would not want to identify it definitely as to species".

This, assuming the identification as correct, is the first record of the capture of this more southern fish in our waters.

SALPS.

Salpa (*Jasis*) *zonaria* (Pallas 1774).

In the autumn of 1937, this form was brought in from both Emerald and the Western part of Sable Island Bank during October and November on several occasions by the schooner M. B. Tanner.

It was also reported as commonly seen in Halifax Harbour by Mr. C. K. Darrach of the Fisheries Experimental Station during this same period.

On November 17, the author found small windrows of them left on a beach by the receding tide in St. Margaret Bay just west of Halifax. Numbers were also seen in the waters off this beach.

In 1938, however, the abundance of these organisms was greatly increased.

During the summer the schooner M. B. Tanner reported that they were quite numerous on the Grand Banks and also around Emerald Bank in September. Another record is from the M. V. Zoarces which had a string of salps caught around the deep-sea water bottle on August 30, 45 miles west of Middle Bank.

At Grand Manan in the Bay of Fundy the cod were found to be eating these in October.

Reports from several ports along the outer Nova Scotian coast are to the effect that this form was not numerous outside the line of the shore, but that in the bays it was tremendously abundant in September.

In Halifax Harbour, they were so abundant that numerous samples were brought to the Fisheries Experimental Station for identification and some "old timers" around the waterfront said they had never been so abundant before, while others said they had never even seen them previously.

This organism owes its importance to the science of hydrography. Generally, it is foreign to our waters, but on numerous occasions it has accompanied shoreward movements of offshore waters along the outer Nova Scotian coast and in the autumn of 1938 its sudden great abundance inshore instigated hydrographic work which checked the fact that a large scale shoreward movement of offshore surface water had taken place recently.[12] Such movements have been shown to follow the formation and subsequent movement of North Atlantic tropical cyclones, and on this occasion this "storm warning" was a day ahead of the weather bureau's, because this storm—devastating in its effect in New England—had not crossed the usual shipping routes from where such information is obtained.

Some interesting observations go to show, also, that these Salps are positively phototropic.

On very dull days few were seen at the surface off the ends of the wharves, but on bright days the water seemed "alive" with them. On several occasions, too, when the fog cleared and the sun shone, they were observed to gradually come to the surface from so far down that they had not been seen previously.

Again, some were kept in a gallon jar on board the schooner M. B. Tanner. During sunny weather when kept in the pilot house they were very active. On dull days they were not so active, and at night they all rested on the bottom of the jar, resuming activity with the approach of daylight. If they were taken from a dark place at night and put in the lighted cabin. they immediately began swimming all about the jar.

PRESIDENTIAL ADDRESS.

G. H. Henderson.

(Read October 12, 1938).

Last year I had to record with sorrow the deaths of four of our members, an unusually high number. This year, unfortunately, the number is even greater, for we have to mourn the deaths of six of our members.

Mr. D. W. Robb, of Amherst, was one of our oldest members, having been elected on March 4th, 1890. Born at Amherst on May 9th, 1856, he was long associated with the industrial life of that town. He took an active interest in public affairs and was a member of Royal Commissions concerning the eight hour day in industry and also the feasibility of the so-called Chignecto Canal.

Dr. Allan R. Cunningham was born at Dartmouth 58 years ago and died at Saranac Lake on July 3, 1938. He graduated from Dalhousie with the degrees of B.A. in 1900 and M.D. in 1904. A well known specialist in diseases of the eye, ear, nose and throat, he was keenly interested in the progress of science. He was for many years a regular attendant at scientific meetings in Halifax including the Institute, to which he was elected on Dec. 1, 1921.

Dr. G. M. J. MacKay was born in Pictou on July 29, 1883, the son of the late Dr. A. H. MacKay, formerly Superintendent of Education for Nova Scotia and one of the Institute's most esteemed members. On graduation from Dalhousie in 1905 with High Honours in Chemistry he was awarded an 1851 Exhibition Scholarship and took postgraduate work at the Massachusetts Institute of Technology. Shortly after receiving the degree of M.Sc. from that institution he joined the staff of the Research Laboratory of the General Electric Company in Schenectady where he became head of the section of Electrical Insulation. During the War he rendered valuable service in research on submarine detection devices and nitrogen fixation. In 1933 he resigned to become Director of Research for the American Cyanamid Company in the new laboratories at Stamford, Conn. In recognition of his distinguished scientific career and of his broad-minded qualities as a citizen he was honoured by his alma mater with the degree of LL.D. in 1936. He had been a member of the Institute since Dec. 28, 1903. He died at his summer home in New York State on his fifty-fifth birthday.

An uncle of the foregoing, Dr. Hector H. MacKay of New Glasgow, died at his home on Sept. 25, 1938. He was born at Plainfield, Pictou County, 80 years ago. A graduate of Pictou Academy and McGill University he had practised his profession in New Glasgow for nearly half a century and was highly esteemed both as physician and as citizen. He joined the Institute as Associate Member on Feb. 4, 1902, and always took a great interest in our work. The Institute has indeed been fortunate in having as its members the three members of that distinguished family, A. H., G. M. J., and H. H. MacKay.

On October 2, 1938, there passed away Dr. Arthur Stanley MacKenzie. Born in Pictou on Sept. 26, 1865, he graduated from Dalhousie with honours in mathematics and mathematical physics in 1885. After acting as Instructor at Dalhousie for a time he entered Johns Hopkins University to study physics under H. A. Rowland. Receiving the degree of Ph.D. in 1894 he was for a number of years Professor at Bryn Mawr College. He came to Dalhousie as Professor of Physics in 1905 and in 1911 was made President of the University, a position which he adorned for twenty years. He published a number of important papers on physics and was active in research until administrative demands became too great. He had been a member of the National Research Council since the beginning in 1916 until retirement at his own request only a few months ago. He was Chairman of the Nova Scotia Economic Commission since its inception in 1936. Dr. MacKenzie was a very good friend of the Institute, which he joined on Nov. 7, 1905. I shall recall here only his recent service to us in securing aid in the publication of our Catalogue of Scientific Periodicals in the Maritime Provinces and in the arrangements made for our 75th Anniversary meeting. Science and education in Nova Scotia owe an immeasurable debt to Dr. MacKenzie, the many items of which I shall not attempt to assess. His tall stately figure, his rare and engaging personality, his keen mind and wise counsel, and his spirit of high ideals and intellectual honesty will be sorely missed.

Just before this meeting, the death was announced of W. G. Yorston, a life member of the Institute which he joined on Nov. 12, 1892. Mr. Yorston died at Nevada, Miss., on Oct. 5, 1938, after a lengthy illness. He had been well known as an engineer in the service of the Government of Nova Scotia.

To the families of these our deceased members, the Institute offers its deepest sympathy.

During the past year seven ordinary meetings were held in addition to the annual business meeting. The attendance averaged over 25 per meeting. Nineteen papers dealing with original work and two demonstrations were presented at the meetings. There were four papers in the field of Biochemistry, three each in Chemistry, Physiology and Zoology, two each in Fisheries and Physics and one each in Bacteriology and Botany. The largest attendance was at a meeting which included a demonstration and a paper involving a demonstration. I would urge that our members try to introduce as many demonstrations as possible in order to increase interest and attendance.

During the year there were elected seven ordinary, one associate and nine student members. The annual Provincial Government grant of $500 was again given during this year.

Volume XIX, Part III, of our Proceedings has been issued during the year containing 78 pages. Included in it is the address on "Research in Canada" given by Major-General MacNaughton on the occasion of our 75th Anniversary. Separate copies have been sent to all members of the Nova Scotia Legislature among others. The Institute also published as a separate reprint, sent to all members, the biographical sketch of Titus Smith, the Dutch Village Philosopher, prepared by Mr. Piers as part of his Presidential Address two years ago. Volume XIX, Part IV, of the Proceedings is already in proof and publication can be expected shortly. This is a large number and great credit is due the Editor, Dr. King, for bringing it forward so rapidly. It should be mentioned that the costs of this Part will be correspondingly high and will bear heavily on our treasury.

The Council continued for another year the policy initiated last year of paying part of the travelling expenses of outside members coming to Halifax to present a paper at one of the ordinary meetings. This privilege was again taken advantage of by a member of the Atlantic Biological Station at St. Andrew's, New Brunswick, Dr. R. H. McGonigle, who gave a very interesting paper of temperatures in certain fresh waters. This scheme has now been tried out experimentally for two years and the papers which have been given to the Institute have been well delivered and have been received with much interest and discussion. This meeting might usefully discuss the future of the scheme, for the guidance of Council.

The receipt of periodicals in the Library has been well maintained through our exchange lists. Thanks to the Provincial Grant to the Provincial Science Library a number of new books have been added and the borrowing of books has again shown a gratifying increase. It is evident, too, that the amount devoted to binding is beginning to make an inroad into the large accumulation of unbound volumes of scientific periodicals upon the shelves. We may look forward to a gradual elimination of the arrears, although the progress is not as fast as we could wish. There is practically no overlapping between this Library and other scientific libraries in the city, such as Dalhousie and the Fisheries Station. Among them there can be found, as there should be in the Capital City of the Province, most of the scientific periodicals which form so important a tool in the application of science for the good of the Province.

In retiring from the office of President of the Nova Scotian Institute of Science I wish to take the opportunity of stressing another aspect of the importance of science for the common good of the Province, namely with respect to the Provincial Museum. Toward this, as toward the Provincial Science Library, the Institute has always stood in the relation of godfather, though its means have been too slender to justify the adjective of fairy. Our present Museum, under the care of its Curator, one of our oldest and most faithful members, has done fine work and attracts increasing interest both from residents and from tourists. But it is suffering from an impossible handicap. It is housed in a building designed for another purpose which is not fireproof, and it is congested beyond hope of remedy.

The idea of a Museum has undergone a complete change in the last few years, at least in the mind of the general public. It formerly meant a storehouse for the accumulated (and sometimes unwanted) treasures of the past. The very name implied something dead—a place for the elderly rather than for youth. To-day it is regarded as one of the most effective forms of education, both youthful and adult. It is alive to the needs of our present day civilization.

That this transformation of a Museum is not an opinion but a fact may be seen from the example of our sister Provinces. To go no further, the Royal Ontario Museum in Toronto, the Provincial Museum in Quebec and the Provincial Museum in Saint John have risen anew in the past ten years. Here in Nova Scotia the problem is urgent. It is not too much to hope that with or without private benefaction, civic and provincial support will fill this obvious gap.

It may not be realized that in Nova Scotia the problem is already partly solved. A Museum can be said to have two sides—the historical and the scientific—though a sharp line should not be drawn between them. Here we already have the Provincial Archives—unexcelled in Canada—which takes care of the documentary and pictorial problems of a Museum. Relieved of these responsibilities and acting in close cooperation with the Archives, much could be made of a Museum. It should be primarily scientific in the broadest sense of the word. In it would be found exhibits of the natural resources of the Province and displays telling the story of the long civilization of Nova Scotia. Emphasis could be placed on working models of our mining, (coal, gold, gypsum and salt), of our fisheries and agriculture and industries. Also there could be working models of modern mechanisms which play so large a part in our modern life, and of some of the fundamental experiments of science—science which has transformed our way of living and threatens its disruption if not better understood.

Such a pair of institutions—Archives and Museum—working together would form an incalculable asset to our Province. It is a realizable dream and one towards whose fulfilment the whole hearted efforts of the Institute of Science should be turned.

In conclusion I wish again to express my appreciation of the honour which you have done me in electing me as President. To the officers and to members of Council of the Institute I wish to extend my thanks for their help and forbearance.

PROCEEDINGS OF MEETINGS.

SESSION OF 1938-39.

(All ordinary meetings were held in the Medical Science Building, Halifax).

77th Annual Business Meeting, October 12th, 1938. The annual address of the President was read by Dr. G. H. Henderson.

The Treasurer's Report showed that the receipts for the year amounted to $1,666.35; expenditures $430.21; leaving a balance of $1,236.14. The Reserve Fund consists of $253.58 in Dominion Savings and $500.00 in Dominion of Canada 4% bonds. The Permanent Endowment consists of (a) Telephone Bonds, 6% to 1941, then 4½% to 1966, $1,000.00, (b) Two Dominion of Canada Bonds 4½%, $1,000.00, (c) Dominion of Canada, 4%, $500.00.

The Corresponding Secretary reported that during the past year 64 back numbers of the "Proceedings" had been sent out. The exchange list now consists of 851 addresses.

The Librarian's Report, delivered by Mr. Piers, was as follows: "I beg to report that during the year ending 30th September, 1938, the Nova Scotian Institute of Science, through its exchange list, received 2,106 books and pamphlets."

Officers elected for 1938-39 were as follows:

President	Dr. H. S. King.
1st Vice-President	Professor R. J. Bean.
2nd Vice-President	Dr. Ernest Hess.
Treasurer	D. J. Matheson, Esq.
Corresponding Secretary	Dr. D. LeB. Cooper.
Recording Secretary	Dr. F. R. Hayes.
Librarian	Harry Piers, Esq.
Members of the Council	Dr. G. H. Henderson, C. R. K. Allen, Esq., E. W. Todd, Esq., H. Roy Fraser, Esq., Dr. Dixie Pelluet, Dr. R. D. H. Heard, Dr. C. B. Weld.
Auditors	Professor W. P. Copp, P. R. Colpitt, Esq.

Nominees to the Government as members of the Provincial Science Library Commission . . Dr. G. H. Henderson and Dr. Ernest Hess.

1st Ordinary Meeting, Nov. 7th, 1938. New members announced (elected by Council, October 24, 1938); Ordinary member: Dr. M. K. McPhail. Associate member: James L. Bowlby, Esq. Student member: J. K. Dingle.

Papers: The Inorganic Nutrient Requirements of *Bacillus Coli Communis*. By Robert Begg. Photometric Measurement with the Ordinary Colorimeter: Hemoglobin Determinations. By C. B. Weld. A Study of Fish Spoilage. By V. K. Collins.

2nd Ordinary Meeting, Dec. 5th, 1938. New student members announced (elected by Council, Nov. 21, 1938); J. K. Bell, R. C. Langille, and J. P. Walsh.

Papers: An Undescribed Compound of Histidine. By W. W. Johnston. Synthesis of d:l-β-3:4-dihydroxyphenyl-N-methylalanine. By R. D. H. Heard.

3rd Ordinary Meeting, Jan. 23rd, 1939. New members announced (elected by Council, Jan. 9, 1939); Ordinary member: Dr. Alan E. Cameron. Student members: J. C. Arnell, G. S. McKnight, and M. M. Hoffman.

Papers: The Ultracentrifugal and Electrophoretic Analysis of the Proteins of Egg White. By E. Gordon Young. Hydrolysis of the Conjugated Oestrogens of Mares' Pregnancy Urine. By M. Edson and R. D. H. Heard. Canadian Atlantic Cod Migrations. By R. A. McKenzie.

4th Ordinary Meeting, March 13th, 1939. New corresponding member announced (elected by Council, Feb. 6, 1939); Dr. M. L. Fernald.

Demonstration: A Rubberless Counterbalanced McLeod Gauge. By G. H. Henderson. Papers: Some Maritime Marine Fish and Salp Records. By R. A. McKenzie. A New Type of Calorimeter. By C. C. Coffin.

5th Ordinary Meeting, April 10, 1939. New members proposed (elected by Council, April 24, 1939); Associate member: Dr. G. F. M. Smith. Ordinary member: George Barrett, Esq.

Papers: Pneumothorax Gases. By C. B. Weld. The Ultra-violet Absorption Spectrum of Salmon Egg Oil. By J. H. L. Johnstone and F. R. Hayes. Demonstration: Glass Manometers. By C. C. Coffin and J. C. Arnell.

F. Ronald Hayes,
Recording Secretary.

ABSTRACTS.

(Papers read before the Institute but not published in the Proceedings).

The Inorganic Nutrient Requirements of *Bacillus Coli Communis.* Robert Begg, Dept. of Biochemistry, Dalhousie Univ., Halifax, N. S. (Read Nov. 7, 1938). (1) Bacillus coli communis can grow and reproduce through serial subcultures on a medium containing less than one and six parts per hundred million for copper and calcium and less than one part per million for iron and magnesium respectively. (2) Magnesium is a powerful growth stimulant for Bacillus coli, iron, copper and calcium having little effect. (3) Much investigation must be done before the elucidation of the inorganic nutrient requirements of Bacillus coli communis is completed. (4) Methods and apparatus are described which may be used for the purification of glycerol, sodium chloride, ammonium sulphate, and the mono-basic potassium and the di-basic sodium phosphates.

Photometric Measurement with the Ordinary Colorimeter: Hemoglobin Determinations. C. B. Weld, Dept. of Physiology, Dalhousie Univ., Halifax, N. S. (Read Nov. 7, 1938). By using a series of (Ilford) "spectral" color filters on the eyepiece of the colorimeter, the light passing through the colorimeter is rendered virtually monochromatic. The light absorbing power of the unknown solution is compared with that of a standard neutral grey screen. Absorption spectra so determined have been made with oxyhemoglobin, acid hematin and the Newcomer glass standard for hemoglobin determinations. The Newcomer standard shows serious quantitative differences from the acid hematin it is supposed to represent, absorbing more blue and less yellow. The discrepant findings between the Newcomer (color method) and the Van Slyke (gasometric method) determinations for hemoglobin, previously reported, have been confirmed. The absorption spectra of the different bloods are all similar and hence it is concluded that the discrepancy is at least not due to some admixing color.

A Study of Fish Spoilage. V. K. Collins, Fisheries Experimental Station (Atlantic), Halifax, N. S. (Read Nov. 7, 1938). The use of trimethylamine oxide and of lactic acid by bacteria shows their significance in fish spoilage. The changes in these substances and their end-products are studied quantitatively.

An Undescribed Compound of Histidine. W. W. Johnston, Fisheries Experimental Station (Atlantic), Halifax, N. S. (Read Dec. 5, 1938). In the course of an investigation on the extractives of certain fish muscles a salt was isolated which has been identified as a compound of histidine with barium nitrate.

The Synthesis of d:l-β-3:4-Dihydroxyphenyl-N-Methylalanine. R. D. H. Heard, Dept. of Biochemistry, Dalhousie Univ., Halifax, N. S. (Read Dec. 5, 1938). The above-mentioned dimethylamino acid was synthesized with a view to a study of its biological oxidation with reference to the synthesis of adrenaline in vivo.

The Ultracentrifugal and Electrophoretic Analysis of the Proteins of Egg White. E. Gordon Young, Dept. of Biochemistry, Dalhousie Univ., Halifax, N. S. (Read Jan. 23, 1939). An attempt has been made to determine the physical condition of the protein in native egg white by physical means. Ultracentrifugal methods have been shown to be of little help because of experimental limitations. Using the cataphoretic apparatus of Tiselius egg white has been demonstrated to possess six boundaries of varying densities. It is further shown by this technique that ovomucin and ovomucoid as at present prepared consist of several protein fractions.

Hydrolysis of the Conjugated Oestrogens of Mares' Pregnancy Urine. M. Edson and R. D. H. Heard, Dept. of Biochemistry, Dalhousie Univ., Halifax, N. S. (Read Jan. 23, 1939). Conditions have been established which secure optimum conversion of the water soluble biological inactive conjugated oestrogens of mares' pregnancy urine into the ether soluble physiologically potent free hormones. Maximum hydrolysis of the combined forms in early, middle and late pregnancy urine is obtained under the same conditions in spite of the variation in relative amounts of the different hormones which are known to occur.

Canadian Atlantic Cod Migrations. R. A. McKenzie, Fisheries Experimental Station (Atlantic), Halifax, N. S. (Read Jan. 23, 1939). The movements of the codfish may be divided into three main types. Some fish remain approximately in one region all the time, shifting only on and off shore a few miles with the change of seasons. These may be classed as "natives" or "residents", having a very restricted type of migration. Other fish may move along a definite route season by season, returning to approximately the same region by the same time the following year. These have an extended type of migration. Still other fish move away from a given point and appear never to return to it. These may be called "rovers" or "wanderers".

A New Type of Calorimeter. C. C. Coffin, Dept. of Chemistry, Dalhousie Univ., Halifax, N. S. (Read March 13, 1939). An isothermal naphtholene calorimeter analagous to the Bunsen ice calorimeter has been developed. The outer bath consists of the vapour of benzene boiling under a definite adjustable pressure so that the sign and magnitude of the heat leak can be readily controlled. Various tests of the apparatus are described and some possible uses are discussed.

The Ultra Violet Absorption Spectrum of Salmon Egg Oil. J. H. L. Johnstone and F. R. Hayes, Depts. of Physics and Biology, Dalhousie Univ., Halifax, N. S. (Read April 10, 1939). Estimations were made with a Hilger Spectro-photometer of the absorption of ultra violet light by oil extracted from developing salmon eggs. No absorption band was detected at 3300, which led to the conclusion that Vitamin A, if present at all, must have been in very small quantities—less than 2 International Units per egg. A band was observed at 2600-2700 with $E^{1\%}_{1\text{cm.}}$ of about one, suggesting the presence of Vitamin D or some sterol related to it. There was no clear evidence that any change took place in the intensity of this latter band during development.

NOTICE TO AUTHORS.

To be printed in the volume of the year, a paper must be submitted for publication on or before the date of the May meeting.

Manuscripts should be typewritten (double spaced) on one side of the paper, 8½ x 11 inches, with 1 to 1½ inch margins. The original typewritten copy should be furnished.

An abstract, not over 200 words in length, must be placed at the beginning of the article. It should be suitable for reproduction in abstract journals. As an index, it should be complete; all the subjects, major and minor, concerning which new information is presented, should be mentioned. As a summary, the abstract should give briefly the conclusions of the article, important advances in experimental technique and in theory, and numerical results of general interest. For an excellent type of abstract see "The Physical Review". A summary at the end of the article should be omitted since it is included in the abstract.

Citations to the literature and notes will be placed at the bottom of the page and should be indicated in the text by superscript numerals, numbered consecutively from 1 up. All footnotes should be collected on a separate manuscript page for the benefit of the printer. The form of citations should be as indicated by the following examples:

[1]Thomson, *Phil. Mag.*, [7] **3**, 241 (1927).

[2]Bachem, *Arch. exptl. Path. Pharm.*, **122**, 69-76 (1927); C.A., **22**, 274 (1928). No reference should be cited which has not been consulted by the author himself. When only an abstract is available, it should be indicated in the citation as in the second case above. In abbreviating journal titles employ standard abbreviations used in such well-known abstract journals as "Chemical Abstracts". In citing books, use the form shown in the following example:

[3]Mellor. "*Inorganic and Theoretical Chemistry,*" Longmans, Green and Co., London. **1923**, vol. 4, pp. 625, 645.

In constructing tables arrange them to leave as little waste space as possible. All drawings intended for reproduction should be made about twice the size of the proposed cut on white paper or on tracing linen. They should be drawn with extreme care, preferably by a draftsman. Material in each figure should be arranged compactly. It is well where possible to make the longer dimension horizontal. All lines that are to be reproduced must be sufficiently heavy to be clearly legible in the finished cut. When coordinate paper is used, it should be printed in blue only, with the important lines ruled over in black; the black squares in general should be not less than ten millimeters on a side in the printed cut. The lettering of cuts, when reduced, should be about the size of the letters in the text. The Institute bears the expense of a limited number of cuts only. Where necessary half-tones for reproduction on special paper will be accepted at the author's expense.

Unless page proofs are specifically asked for, galley proofs only are sent to the author for correction. Proofs should be corrected with great care and returned by next mail to the Editor, Dr. Harold S. King, Dalhousie University, Halifax, N. S.

The Institute furnishes the author of each paper with 50 reprints without covers gratis. Additional copies may be obtained at reasonable rates if applied for at the time of return of the proof to the Editor. If covers to reprints are desired, an extra charge is made.

PRINTED
IN CANADA

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOL. XX. 1939-1940 PART 2

Museum of Comparative Zoology
OCT 25 1940
LIBRARY

CONTENTS

A Preliminary List of the Fishes of Malpeque Bay. A. W. H. Needler 33

Some Marine Records from Nova Scotian Fishing Waters. R. A. McKenzie 42

Presidential Address. Harold S. King 47

Proceedings of Meetings. Session of 1939-40 50

Abstracts. (Papers read before the Institute but not published in the Proceedings.) 53

Editor: Harold S. King.
Editorial Board: E. G. Young, E. Hess and G. H. Henderson.
Printed for the Institute by Imperial Publishing Co., Ltd.
Date of Publication: October 17, 1940.

6253

Museum of Comparative Zoology
OCT 25 1940
LIBRARY

PROCEEDINGS
OF THE
Nova Scotian Institute of Science

SESSION OF 1939-40
(Vol. XX, Part 2)

A PRELIMINARY LIST OF THE FISHES OF MALPEQUE BAY*

A. W. H. NEEDLER.
Prince Edward Island Biological Station,
Ellerslie, P. E. I.

(Received August 16, 1939).

ABSTRACT.

Malpeque Bay, on the north side of Prince Edward Island, is separated by a long barrier beach from the southern Gulf of St. Lawrence where the temperatures, salinities and fauna are quite different. Commercial fishing is limited to herring, alewives, smelts, mackerel, eels and oysters. Twenty-seven other non-commercial fishes are listed as occurring in this region. The only two previous lists for this general area of the Gulf recorded sixteen and twenty-six species respectively. Common species not listed previously include *Pomolobus*, *Salmo*, *Pungitius*, *Apeltes*, *Siphostoma*, *Menidia*, *Myoxocephalus aeneus*, and *Microgadus*, while less typical ones include *Raja scabrata*, *Scomberesox*, *Ammodytes*, *Poronotus*, *Pholis*, *Limanda* and *Lophopsetta*. Information is also given concerning the recent abundance of eels, the herring and smelt fishery, and the great abundance of silversides, as well as on the sizes, abundance and habitats of a number of the other species.

The fish fauna of Malpeque Bay, as shown by the existing records, is listed here as an example of many similar bays in the southern Gulf of St. Lawrence. These shallow, sheltered bays with their great seasonal range in temperatures have their characteristic fish fauna. Malpeque Bay is typical of those with relatively small drainage basins and, consequently, relatively high salinities.

The area of the bay is about 40,000 acres. It has highly indented shores and long branches, called locally "rivers" and creeks. A barrier beach many miles long separates the bay from the open Gulf of St. Lawrence leaving only a narrow entrance. The greatest depth is just over 50 feet and most of the bay is much shallower.

---

*Published by permission of the Fisheries Research Board of Canada.

Although the normal tidal range is only from two to three and a half feet, the drainage area is so small that, in spite of the small exchange of water with the outside, the salinities remain high. Even towards the heads of the creeks they are commonly over 25 per mille as compared with an average of 28 to 29 per mille just outside the bay. Salinities in the main body of the bay are close to those at the surface outside and sometimes even slightly higher.

The shallowness, small tides and great degree of shelter combine to make the temperatures variable and quickly influenced by weather. For three to five months in the winter the bay and its tributaries are frozen over and the temperatures uniformly below 0° C. In summer, temperatures approach 20° C. throughout the bay and in the sheltered tributaries may exceed that level for some weeks and frequently pass 25° C. The temperature variation is great from day to day as well as from season to season, sometimes amounting to several degrees in two or three days.

The fauna a short distance outside the bay, where cold water is present the year round at moderate depths, is quite different. Records of fish occurring there are included in this list only as an indication of their possible presence in the bay as strays or seasonal visitors. We are concerned only with the fauna inside the bay.

The available data leave many gaps in our knowledge of the fish. Since commencing oyster investigations in the region in 1929 and the establishment of the Prince Edward Island Biological Station there in 1930, the writer has had an opportunity to sample the fish population principally by seining and to a lesser extent by gill-netting and line fishing. Some information has also been obtained by observation of commercial fishing. Gill-netting is carried on for herring in the spring and for smelts in the autumn and winter. Other commercial fishing includes spearing of eels, various oyster culture operations and the lobster fishery, all of which are of interest.

Reference has been made to the earlier published lists of Cornish[1] and Stafford[2]. The former, in his list of the fishes of Tignish, was interested principally in the fishes occurring in the open Gulf of St. Lawrence in this region. He includes several species which have not been found in the inlets and omits forms so important there as *Pomolobus*, *Salmo*, *Pungitius*, *Apeltes*, *Siphostoma*, *Menidia*, *Myoxocephalus aeneus* and *Microgadus*. Forms less typical of the inlets which he does not list are *Raja scabrata*, *Scomberesox*, *Ammodytes*, *Poronotus*, *Pholis*, *Limanda* and *Lophopsetta*. Stafford's list is so brief that it does not pretend to any degree of completeness. He does, however, provide our only record of *Thunnus thynnus* in Malpeque Bay.

Notes on the individual species follow. The nomenclature is that used by Bigelow and Welsh[3] in "Fishes of the Gulf of Maine".

1. *Petromyzon marinus* Linnaeus. Lamprey. Cornish[1] reports this species as being found attached frequently to mackerel and as the latter is common in Malpeque Bay the lamprey may be expected to occur with it.

2. *Raja diaphanes* Mitchill. Big or Eyed Skate. Two specimens (♀ 47 cm. and ♂ 62 cm.) were caught in gill nets, September 21 and October 7, 1932. Cornish[1] reports it as common about the wharves at Tignish in the summer and it may well be common in Malpeque Bay as gear suitable for its capture is seldom used.

3. *Raja scabrata* Garman. Prickly Skate. A single specimen 14 cm. long was seined just inside the mouth of the bay, August 26, 1932.

4. *Anguilla rostrata* LeSueur. Eel. The eel is of common and regular occurrence in the bay throughout the year. It is apparently most abundant towards the heads of the tributary inlets, occurring also in fresh water. During the summer a few are speared at night with a light and in the late autumn

---

[1] Cornish—*Contrib. Can. Biol.* 1906-10, pp. 79-81, 1912.
[2] Stafford—*Contrib. Can. Biol.* 1906-10, pp. 37-44, 1912.
[3] Bigelow and Welsh—*Bull. U. S. Bur. of Fish.*, vol. 40, Pt. I, 567 pp. (1925)

and early spring many are speared in the mud. They commonly occur in seine hauls.

For a few years previous to 1929 they were scarce. In that year and in 1930 numerous small specimens (6 to 12 inches long) were found in bags of shells used for the collection of oyster spat. The abundance of the adults increased, producing a recovery of the fishery first noticeable in 1934.

5. *Clupea harengus* Linnaeus. Herring. Herring are abundant spring visitors to the bay, proceeding at that time well up the tributary inlets though not quite to the head of tide. They support a considerable gill-net fishery commencing almost immediately after the ice leaves which may be from the end of March to the beginning of May. They remain usually for about a month with the peak of the spawning in the latter part of their stay. The temperatures are rising rapidly at this time being close to freezing when they arrive and commonly passing 15° C. within a few days of the cessation of the fishery.

Herring are not known to occur throughout the summer but are present again in the autumn in much smaller numbers than in the spring. Two gill nets set from September 19 to November 1, 1932, at the mouth of Bideford "river" (an important tributary of Malpeque Bay) where important catches are made in the spring, caught only one specimen. It was a spawning male, 27 cm. long, caught on October 7.

6. *Pomolobus pseudoharengus* Wilson. Gaspereau, Alewife. Gaspereaux are common in Malpeque Bay, ascending the brooks to spawn in the early summer, when they are gill-netted in the estuaries. Four specimens were seined, June 22, 1934, in salt water near the head of Bideford "river", of which three were ripe (♀ ♀ 27 cm. and 28 cm., ♂ 24 cm., immature 21 cm.). Eight specimens were seined there July 18, 1937, all spent. No other adults have been seined but a few large individuals (20 to 25 cm.) were gill-netted near the mouth of Bideford "river" in September and October, 1937, and a few are taken in smelt nets in the autumn. They are apparently present throughout the open water season.

Small gaspereaux have been seined in the late summer and autumn: August 26, 1932, 8 specimens, 4 to 7 cm., in three places in the open bay; September 17, 1931, 2 specimens, 9.5 and 10 cm., near the head of Bideford "river"; September 28, 1934, 71 specimens 10 to 13.5 cm., at the mouth of the bay. These small specimens, probably spawned the same summer, seem to be more abundant towards the open than at the heads of the tributary inlets.

7. *Salmo salar* Linnaeus. Atlantic salmon. Salmon ascend the brooks tributary to Malpeque Bay in the late autumn to spawn. A few large salmon become tangled each autumn in gill nets set for smelts in the salt water of the "rivers". Small salmon are commonly caught by anglers in the brooks near the head of tide. A single smolt (13 cm.) was seined, May 21, 1932, in the salt water in Bideford "river" over a mile from fresh water.

8. *Salvelinus fontinalis* Mitchill. Brook trout. Trout are abundant in the tributary brooks of the bay and are often caught in salt water near the head of tide.

9. *Osmerus mordax* Mitchill. Smelt. There is a gill-net fishery for smelts in Malpeque Bay from the middle of October until February. In the spring they spawn generally in the brooks tributary to the bay. Seining indicates that some smelts at least are present throughout the summer both in the open bay and in the tributary inlets. Both young smelts (spawned in the same spring) and yearlings have been seined in the "rivers" in summer and autumn.

10. *Fundulus heteroclitus* Linnaeus. Killifish. Mummichug. This is one of the most abundant fishes of the bay. It has been seined throughout the open water season. Its greatest abundance is towards the heads of the tributary inlets. The largest seen was 13 cm. long and all sizes have been taken down to about 2.5 cm., which appears to be the lower limit for the seines used.

11. *Scomberesox saurus* Walbaum. Needlefish. A single specimen, 40 cm. long, was caught in a smelt gill net in Bideford "river", October 16, 1931. Fishermen did not recollect

ever having seen one before. That there was an unusual invasion of the Gulf of St. Lawrence is suggested by the writer's observation on the same day of two *Scomberesox* in a smelt fisherman's boat at Shediac, N. B. Fishermen there agreed that none had been seen before 1930 and that they were very rare that year and in 1931.

12. *Pungitius pungitius* Linnaeus. Nine-spined Stickleback. This species is common in the "rivers" and creeks, and is apparently present throughout the year. It is most numerous at the heads of the creeks and seined in smaller numbers over a mile down the inlet.

13. *Gasterosteus aculeatus* Linnaeus. Stickleback. This is the most abundant stickleback of the region, as many as 700 being taken in a single haul of 100-foot seine. It is most numerous in the upper parts of the tributary inlets but has also been seined in the open bay. It seems to extend farther seaward than either *Pungitius* or *Apeltes*. It is apparently present throughout the year.

14. *Apeltes quadracus* Mitchill. Four-spined Stickleback. This is the least numerous of the three sticklebacks of the region but is common and generally distributed in the inlets tributary to the bay.

15. *Siphostoma fuscum* Storer. Pipefish. Pipefish were common and generally distributed in seine hauls at the head of Bideford "river" in 1931 though not numerous. They were always found associated with eel-grass and after the mortality of the latter in 1932 were not seen again until the summer of 1938. A few were seined then, again where eel-grass occurred.

16. *Menidia notata* Mitchill. Silverside. This is the most abundant fish of the bay. Hardly a seine haul has been taken without catching several and as many as 3,500 have been taken at once. They seem to be present on all shores throughout the open-water season and can be taken through the ice in winter.

Spawning occurs in June and the young silversides reach lengths up to several centimetres by the end of the summer, showing great individual variation. The size frequencies suggest that most of the spawners are only one year old, although at least one older age group is present.

17. *Ammodytes americanus* DeKay. Sand launce. Sand launce have been seined in the autumn near the mouth of the bay and near the mouth of Bideford "river". Numerous small launce (4 to 6.5 cm. long) were seined for the first time towards the head of Bideford "river" July 18, 1937, and a few again in 1938. Larger areas of sandy bottom occur towards the open and the launce seem to be more numerous there.

18. *Scomber scombrus* Linnaeus. Mackerel. These are regular summer and early autumn visitors to the Gulf just outside the bay where they are hooked in considerable numbers. Twenty-three from 26 to 45 cm. long were gill-netted at the mouth of Bideford "river" September 20 to October 10, 1932. A single specimen 20 cm. long was seined at the head of Bideford "river" in September, 1931. They may visit the bay regularly in considerable numbers, as little gear suitable for catching them is employed before the middle of October.

19. *Thunnus thynnus* Linnaeus. Tuna, albacore. Stafford[2] reports seeing a specimen stranded on mud flats near the mouth of the bay.

20. *Poronotus triacanthus* Peck. Butterfish. A single specimen 13 cm. long was gill-netted at the mouth of Bideford "river" in September, 1932.

21. *Roccus linneatus* Bloch. Striped bass. Striped bass are gill-netted in small numbers in early summer towards the head of Grand "river", one of the two large inlets tributary to the bay.

22. *Tautogolabrus adspersus* Walbaum. Cunner. Small cunners, locally called "perch", are common throughout the bay. They have been seined from the mouth of the bay to the creeks and are commonly found in bags of shells used for the collection of oyster spat, in lobster traps, etc. None larger than 13.5 cm. have been seen by the writer in this region.

23. *Myoxocephalus aeneus* Mitchill. Little sculpin. This is the common sculpin of the bay. It has been seined commonly both in the open bay and in the tributary inlets and is often taken in gill-nets. It is probably present throughout the year.

24. *Myoxocephalus octodecimspinosus* Mitchill. Longhorn sculpin. This species is present but not abundant. It occurs in the catches of smelt gill-nets in the autumn. One specimen was seined at the mouth of the bay, August 26, 1932, and four at the mouth of Bideford "river", November 2, 1934.

25. *Pholis gunnellus* Linnaeus. Rock eel. A few rock eels have been seined and the newly spawned eggs have been taken.

26. *Microgadus tomcod* Walbaum. Tomcod. The tomcod is one of the common fishes of the inlets tributary to Malpeque Bay, appearing in seine hauls near the head of Bideford "river" at all seasons. It is also commonly taken in the gill-nets of the herring fishery in the spring and of the smelt fishery in the autumn and early winter. Ripe fish have been observed in the late autumn and small tomcod (less than 5 cm. long) have been seined in June.

27. *Gadus callarias* Linnaeus. Cod. Though fished commercially just outside, cod have never occurred in our seine hauls or been observed by the writer inside the bay. They are included here only on the strength of a reported autumn fishery in the past in the deep water of the main channel just inside the mouth of the bay.

28. *Urophycis tenuis* Mitchill. Hake. Small hake, which appear to belong to this species, are common in the autumn in the tributary inlets. They appear in two size groups, the smaller reaching lengths of 15 to 20 cm. and the larger 25 to 32 cm. in the autumn. They occur in seine hauls and in gill-nets set for smelts. In gill-nets set at surface and bottom at the mouth of Bideford "river" in 1932 many hake were taken in the surface net and none at the bottom.

29. *Limanda ferruginea* Storer. Rusty dab. Three spent females, 23 to 29 cm. long, were seined at the mouth of the

bay on August 26, 1932. Two small specimens, 7 and 8 cm. long, were taken in the same haul, and two others, 3.5 and 11 cm. long, at the mouth of Bideford "river", November 2, 1934. This species has never been taken in the more numerous seine hauls farther up the inlets.

30. *Pseudopleuronectes americanus* Walbaum. Winter flounder.

31. *Liopsetta putnami* Gill. Smooth flounder. Both these flounders are abundant in Malpeque Bay and its tributaries. They are apparently present throughout the year and all lengths up to 25 cm. are well represented with a few winter flounders up to 30 cm. The very small of both are present, and spawning winter flounders have been taken in June. There seems to be a tendency for the smooth flounder to be relatively more abundant on soft, mud bottoms and the winter flounders on firmer grounds.

32. *Lophopsetta maculata* Mitchill. Sand flounder. Eight small individuals, 3 to 8 cm. long, were seined at the mouth of the bay, August 26, 1932, and eleven, 5 to 13 cm. long, were seined at the mouth of Bideford "river" in November, 1934. This species, like *Limanda ferruginea,* has not been taken towards the heads of the inlets. No large individuals have been taken.

SOME MARINE RECORDS FROM NOVA SCOTIAN FISHING WATERS.*

R. A. McKenzie.

Atlantic Biological Station, St. Andrews, N. B.

(Received June 11, 1940).

ABSTRACT.

Mention is made of the occurrence of the following six rather rare fishes,—*Cetorhinus maximus*, *Coregonus clupeaformis*, *Notacanthus chemnitzi* (*nasus*), *Decapterus macarellus*, *Dactylopterus volitans*, *Anarhichas latifrons*. The possible maximum size records for *Hippoglossoides platessoides* and *Sebastes marinus* are reported and the capture of a beaked whale, *Mesoplodon densirostris*, is recorded, as well as the distribution of the salp *Salpa* (*Jasis*) *zonaria* during 1939.

INTRODUCTION.

The following notes on the occurrence of these forms are presented with a view to having them recorded permanently for the use of naturalists in the future. Each record is put forward because some feature it possesses is deemed worthwhile.

Appreciation is herewith extended to Professor J. R. Dymond, Mr. J. T. Nichols and Mr. Wm. C. Schroeder for their assistance on many occasions.

FISHES.

Cetorhinus maximus (Gunnar) 1765. Basking Shark.

Until recently (McKenzie, 1939)[1] there were no positive records of the capture of this species in Nova Scotian waters. Two further records are herewith submitted.

On July 4, 1939, a large specimen was taken in the fish trap at Sandford, Yarmouth. This fish, a male, measured 7.7 m. (25¼ feet) in length and according to Schultz[2] should have weighed 3,266 kgm. (7,200 lb.).

About August 16, 1939, E. W. Maynard of Wilmington, Delaware, caught the other specimen off Digby, N. S. It measured 3.7 m. (12 feet) in length and actually weighed 353.8 kgm. (780 lb.) when bled. It is interesting to note that according to Schultz's[2] graph this fish should have weighed 408.2 kgm. (900 lb.). The bleeding of this specimen may account to some extent for the actual weight being less than the calculated weight.

---

*Published by permission of the Fisheries Research Board of Canada.

[1] McKenzie—*Proc. N. S. Inst. Sci.*, 20, Pt. I, 13-20, 1938-39 (1939).

Coregonus clupeaformis (Mitchill) 1818. Whitefish.

In 1927 Piers[3] reported the occurrence of this species in the Petite Riviere at Millipsigate Lake, Lunenburg County, which had probably been artificially introduced.

In the early summer of 1938, a small male specimen 24 cm. (9½ inches) in length was taken, along with several others, below a mill dam on one of the headwater tributaries of the west branch of the Lahave River, Lunenburg county, Nova Scotia. This stream is located several miles southwest of Hemford and about fifteen miles north of the lake mentioned by Piers. There is no apparent connection between these two river systems, though they are close together.

This specimen is in Anderson's museum at Lunenburg, Nova Scotia.

Notacanthus chemnitzi (nasus) Bloch 1787. Spiny Eel.

This species or a closely related one was first recorded for our waters (south of Sable Island, February 10, 1935) by Bigelow and Schroeder[4].

However, the two present specimens, 91 cm. (36½ inches) and 78 cm. (31¼ inches) in length respectively were taken, along with several others not saved, by the steam trawler *Administrator de Bournat*, (Capt. Chas. LeMesle), March 10, 1940, in 56-125 fathoms along the southern edge of the Grand Banks of Newfoundland, approximately Lat. 44° 30′ N., Long. 53° 30′ W.

The only other capture of this species in the Grand Banks area was recorded by Goode and Bean, 1895[5].

Hippoglossoides platessoides (Fabricius) 1780. Canadian Plaice.

When fishing May 6, 1939, off the northwest lighthouse of

---

[2] Schultz—*Jour. Mammology*, vol. 19, no. 4, November 14, 480-487, (1938).

[3] Piers—*Proc. Trans. N. S. Inst. Sci.*, 16, 92-95, 1927.

[4] Bigelow and Schroeder—*Proc. Boston Soc. of Nat. Hist.*, vol. 41, no. 2, 13-18, (June, 1935).

[5] Goode and Bean—Oceanic Ichthyology, *Smithsonian Institution U. S. Nat. Mus.*, Spec. Bull. no. 2, 553 pp., 1895.

Sable Island (Lat. 44° 8′ N., Long. 60° 10′ W.) in 30-40 fathoms, the schooner *K. V. Colin* captured an exceptionally large specimen of this species. It measured 81.2 cm. (32½ inches) in length and weighed 6.3 kgm. (14 lb.) gutted. The largest specimen known previously, 70.6 cm. (28¼ inches) taken on Western bank in September, 1934, was recorded by Vladykov and McKenzie[6].

Decapterus macarellus (Cuvier and Valenciennes) 1883. Mackerel Scad.

The present specimen, 6.9 cm. long, was seined by Dr. A. H. Leim at Lawlor's island, Halifax Harbour, on October 3, 1928. Previously, the only other specimens of this species captured in our waters and recorded (Cornish[7]) were taken in trap-nets in Chedabucto bay near Canso.

Sebastes marinus (Linnaeus) 1758. Rosefish.

An exceptionally large specimen of this species was taken by the steam trawler *Administrator de Bournat* (Capt. Chas. LeMesle) about January 25, 1940, along the southern edge of the Grand Banks of Newfoundland in the vicinity of the Whale Deep. This specimen was 68.7 cm. (27½ inches) long and when landed gutted weighed 3.5 kgm. (7¼ lb.). The usual maximum size is considered to be about 61 cm. (24 inches).

Dactylopterus volitans (Linnaeus) 1758. Flying Gurnard.

A small (5.5 cm. approximately) specimen of this species was found in September, 1939, by Stanley McKinley, Wedge Island, Sonora, N. S. (a short distance west of Country Harbour, N. S.) in a dry, hardened condition among the eel-grass and kelp that had washed ashore the previous night. He suspected it had been carried this far north dead on the deck of some steamer from southern waters.

The specimen in reaching its present destination went first to the *Family Herald and Weekly Star*, Montreal, then to Dr. A. Gibson, Dominion Entomologist, Ottawa, and thence to Dr. A. H. Leim, St. Andrews, N. B., who kindly forwarded it to the author.

---

[6] Vladykov and McKenzie—*Proc. N. S. Inst. Sci.*, **19**, Pt. 1, 17-113, 1934-35 (1935).

This species was included by several early authors in their lists of Maine and New Brunswick fishes, but full credence cannot be given their records as no locality was recorded.

Mr. McKinley reports that "about seven years ago he (his father) saw one in Bayport, Guysboro Co., N. S. It was about 8 inches long. Some boys had found it on the shore — — — —."

Because of the indefiniteness of the above reports, this species should not, as yet, be included among the Maritime fishes of Canada.

Anarhichas latifrons Steenstrup and Hallgrimsson 1842.
Broad-headed Catfish.

Up to the present, there have been but three records of the capture of this species in our waters[4,7,8]. A number of them have come to hand, however, more recently.

On October 16, 1937, the schooner *Cachelot III* caught a specimen of this species, 128 cm. (51¼ inches) long on the "eastern shoals" of Banquereau.

The *Cachelot III* again caught two more specimens on November 25, 1937, at Lat. 45° 00′ N., Long. 59° 20′ W. These specimens were 135 cm. (54 inches) and 141 cm. (56½ inches) in length and 18 kgm. (40 lb.) and 19.3 kgm. (43 lb.) in weight.

On December 1, 1937, the schooner *Leah Beryl*, fishing Lat. 44° 55′ N., Long. 57° 30′ W. in 35-70 fathoms caught a specimen 121 cm. (48½ inches) long and 16.4 kgm. (36.5 lb.).

On December 2, 1937, the schooner *I. E. Spindler* fishing Lat. 44° 58′ N., Long. 57° 32′ W. caught two more specimens, 110 cm. (44 inches) and 122 cm. (48¾ inches) in length.

On March 10, 1940, the steam trawler *Administrator de Bournat* (Capt. Chas. LeMesle) when fishing off the Whale Deep region of the Grand Banks of Newfoundland (Lat. 44° 30′ N., Long. 53° 30′ W.) captured a specimen of this species measuring 112 cm. (44¾ inches) in length. While actual records of the capture of this species in the Newfoundland area

---

[7] Cornish—*Contr. Can. Biol.*, 1902-05, 81-90 (1907).
[8] Bean—*Proc. U. S. Nat. Mus.*, 3, 75-116 (1881).

are scarce (Goode and Bean[5] record one and Thompson[9a,b,c.] records none) still Canadian fishermen who operate in this region report that this species is quite common in the deeper water.

WHALE.

Mesoplodon densirostris (Blainville). Beaked Whale.

This Cetacean, or sea-going mammal, was killed February 4, 1940, at Peggy's Cove, N. S., under the wharf of Richard Crooks. It measured 43.4 m. (14¼ feet) in length and according to Schultz[2] it should have weighed about 635 kgm. (1,400 lb.).

According to the many persons, both in the St. Margaret Bay region of Nova Scotia and in Halifax, who viewed this specimen, such a whale has never before been captured in these waters.

On request, this specimen was sent to the Museum of Natural History, New York. Mr. H. C. Raven, a specialist there in this group, specifically identified it on arrival. Specific identification had not been made previously, through fear of damaging it as a scientific specimen, for diagnostic characters are in the mouth which was frozen tightly shut.

SALPS.

Salpa (*Jasis*) *zonaria* (Pallas 1774).

Unlike 1938, when this form of life was so extraordinarily abundant along the Nova Scotian coast (McKenzie[1]), 1939 was practically a barren year in this respect.

Early in June, a fisherman found some salps attached to the hooks on his line-trawl as he fished in the mouth of Halifax Harbour. The water temperature ranged from about 0° C. at the bottom in 35 m. to 8° C. at the surface.

During the autumn of 1939, no salps were seen in Halifax Harbour or St. Margaret Bay. The many fishermen questioned also reported that they too had not seen any this year in contrast to their great abundance in 1938.

---

[9] Thompson—(a) *Rept. Nfld. Fish. Res. Comm.*, vol. 1, no. 4, 107-110, 1931 (1932).
(b) *Rept. Nfld. Fish. Res. Comm.*, vol. 2, no. 1, 125-127, 1932 (1933).
(c) *Rept. Nfld. Fish. Res. Comm.*, vol. 2, no. 2, 115-117, 1933 (1934).

PRESIDENTIAL ADDRESS.

HAROLD S. KING.

(Read October 11, 1939).

For the last few years the number of deaths reported in the Presidential Addresses has seemed abnormally high. This year we are fortunate in having to report only one. Many of us do not remember Dr. J. Edmund Woodman, at one time Professor in the Dalhousie School of Mining and Metallurgy. Born at Newbury, Mass., July 3, 1873, he passed away on May 20th at the age of sixty-six. From his election in 1902 until he left the Province in 1909 to join the faculty of New York University, he was extremely active in the Institute. For six years he was a member of the Council; for four of these years he served as Vice-President. During this time he gave over a dozen papers and lectures of a geological nature before the Institute. While in the Province, Dr. Woodman was retained by the Dominion government as geologist in charge of the exploration of iron ore and limestone resources in Nova Scotia. After he left us he was a member of the commission which established specifications for the development of the Catskill water supply project for the City of New York.

In reviewing the progress made during the past year, I wish to report that thirteen new members were elected; one corresponding, three ordinary, two associate and seven student members. For some years few corresponding members have been elected. Last February the name of Dr. M. L. Fernald, Director of the Gray Herbarium, Harvard University, was added to this distinguished group in recognition of his work and many papers on the flora of the Maritime Provinces.

At the five ordinary meetings held last year, in addition to two demonstrations, there were twelve papers presented reporting the findings of original research. These papers may be roughly grouped according to subject: four in biochemistry, two each in bacteriology, physiology and fisheries, and one each in biophysics and chemistry. Of these two were submitted for publication in the Proceedings. An attempt should be made to procure a larger number of papers for presentation and especially those available for publication.

Volume XIX, part 4, of the Proceedings was issued last January. With 158 pages exclusive of index, etc., it makes the largest number printed in recent years. It is especially notable in containing an extended account of the birds of the Grand Manan archipelago with an excellent annotated list of the 275 species of birds of that region. Concerning this article P. A. Taverner, Dominion Ornithologist wrote: "If I were a Nova Scotian ornithologist, I should hail this list with considerable pleasure as throwing its light upon the present conditions and limitations of Nova Scotian ornithology." It is to be hoped that in the not too far future a similar account of the birds of Nova Scotia will be forthcoming.

In recent years the number of articles accepted for publication in the Proceedings has been less than in the past, but the standard of articles has been high and the average number of pages per article greater than customary some decades ago. It is to be noted that Volume XIX with 454 pages is the largest volume since 1906.

During the last year, your Council has been deeply concerned with the drawing up of a new Constitution. The result of their labors is to be submitted to you this evening. In formulating this constitution the aim has been to make it as simple and as flexible as possible. If this constitution meets with your approval, the Council will spend another very busy year in drawing up a series of by-laws which are more specific but more easily changed to meet changing conditions. It is proposed to publish the constitution and the by-laws together when completed. At present very few of the members have ever seen a copy of the old Constitution which was printed in 1885 and has long been out of print. The by-laws in force at present are distributed through several volumes of Council meeting minutes and have never been assembled. At present no one knows just what they do or do not cover.

In these days of war and in the uncertainty of what lies ahead, I feel that the best service the Institute can make is to proceed on its way, doing its job and attempting to do it better. The Province has need of such an organization as the Institute and the need will still exist after the war is over. The "promotion of scientific research" is an endless undertaking. The Institute furnishes scientific workers with the opportunity of presenting their work and having it criticized (in the true meaning of the word). In many cases it publishes the work in the Proceedings. Many a science student has made his debut to the scientific world through its pages.

In an effort to help those scientific workers who have papers to offer but who live at a distance from Halifax, the Council initiated some years ago a policy of paying part of the travelling expenses. This has been very successful and has brought us several excellent papers for publication. It is to be hoped that this policy can be continued.

In the past the Institute has felt its sense of responsibility for the scientific education of the general public by presenting exhibitions and popular lectures. At present a science exhibition is out of the question. However, I feel that the Institute could well sponsor or associate itself with some form of educational program of a scientific nature for the benefit of the fighting men in our midst. This is a problem for the Council to consider.

Before closing this brief report, I wish to tell you how much I appreciate the honor you have conferred upon me in electing me as your President. I also wish to stress my obligation, and yours as well, to the very conscientious Council which holds the success of the Institute in its capable hands. It is an exceptionally fortunate organization that has such well-attended council meetings as we have had during the year that is now over.

PROCEEDINGS OF MEETINGS.

SESSION OF 1939-1940.

(All Meetings held in the Medical Science Building, Halifax.)

78th Annual Business Meeting, October 11th, 1939.

The President, Dr. H. S. King, read the annual address.

The Treasurer's report shows the receipts for the year to be $2,394.85; expenditures $1,196.28; reserve for publications in press $400.00; leaving a balance of $798.57. The Reserve Fund consists of Dominion Savings (Post Office) $258.64, and a Dominion of Canada 4% Bond $500.00, totalling $758.64. The Permanent Fund consists of:

(a) Telephone Bonds, 6% to 1941, then 4½% to 1966, $1,000.00.

(b) Dominion of Canada 4½%, $1,000.00.

(c) Dominion of Canada 4%, $500.00. A motion of Dr. Johnstone was passed authorizing a transfer of approximately $500.00 to the Permanent Fund when a suitable investment is found.

The Librarian's report records that there are 103,861 books and pamphlets in the library, that 1,994 books and pamphlets were received during the year and that 2,016 items were borrowed.

A new Constitution was unanimously adopted.

Officers elected for 1939-40 were as follows:

President	Dr. H. S. King.
1st Vice-President	Prof. R. J. Bean.
2nd Vice-President	Dr. Ernest Hess.
Corresponding Secretary	Dr. D. LeB. Cooper.
Recording Secretary	Dr. C. B. Weld.
Treasurer	D. J. Matheson, Esq.
Editor	Dr. H. S. King.
Librarian	Harry Piers, Esq.

Other Members of Council.......Dr. R. D. H. Heard, Dr. F. R. Hayes, George Barrett, Esq., Dr. A. E. Cameron, E. W. Todd, Esq.

Auditors........................Prof. W. P. Copp,
P. R. Colpitt, Esq.

Nominees to the Government as members of the Provincial Science Library Commission..Dr. G. H. Henderson, Dr. Ernest Hess.

1st Ordinary Meeting, Nov. 13, 1939. New ordinary members announced (elected by Council, Oct. 30th), H. R. Wyman, Esq., M.Sc., Hugh Davson, Esq., M.Sc., D. S. Ross, Esq., M.Sc.

Papers: The Carbohydrate Metabolism of Developing Salmon Eggs, by Andrew Hollett. Steroids I. The Isolation of a new Androstanol-3β-one and of Allopregnanol-3β-one-20 from the Urine of Pregnant Mares, by R. D. H. Heard and A. F. Mckay. A Preliminary List of the Fishes of Malpeque Bay, by A. W. H. Needler.

2nd Ordinary Meeting, Dec. 11th, 1939. New student members announced (elected by Council, Nov. 27th). Mark Frank, Esq., B.Sc., and V. K. Collins, Esq., B.Sc.

The following resolution was passed, "In view of the unbearably overcrowded condition of the Provincial Museum, and in view of the great importance of the museum to the educational and scientific life of the Province and as a tourist attraction, the Nova Scotian Institute of Science respectfully requests that as soon as possible adequate provision be made for the museum and for curators, and that in order to carry out these objects the Government pass a Museum Act providing for the establishment of a commission to administer the museum, subject to the authority of the Minister of Mines."

Papers: Calyx End Structure of the Gravenstein Apple, by Hugh P. Bell. Permeability of the Eye Membrane, by Hugh Davson. Fish Enzymes as Leather Bates, by W. W. Johnston.

3rd Ordinary Meeting, Jan. 15, 1940. New members, Miss Helen Wentworth, B.Sc., student and A. St. C. Grant, Esq., M.Sc., ordinary.

Papers: The Oestrus-Inducing Gonadotrophic Substance II. A Comparison of the Infantile and Adult Rat Assays, by R. D. H. Heard. The Production of Dimethylamine in Cod Muscle Press Juice during Spoilage, by V. K. Collins. Eastern Canadian Flat Fishes, by R. A. McKenzie.

4th Ordinary Meeting, Feb. 12th, 1940. Tribute was paid to the late Harry Piers by the following resolution incorporated in the minutes, "This society desires to place on record its deep sense of loss in the death of Harry Piers who for more than 50 years has been a very faithful and active member. For 48 years as member of council and for 40 years as secretary he gave generously of his time and energy, not only to this society but to the advancement of natural science in this province. During these years there were times when he and the late Dr. A. H. MacKay were largely responsible not only for the scientific activity of the Institute but even for its continued existence. For his long service as secretary, for his faithful attendance at its meetings, and for his genuine and unselfish interest in natural science and in research, this Institute is deeply indebted."

Paper: Photo-Dynamic Haemolysis, by Hugh Davson and Eric Ponder. Demonstration: Portable Radium Detector, by G. A. MacDonald.

5th Ordinary Meeting, March 11, 1940. New student members announced (elected by Council, Feb. 26th), L. G. Elliot, Esq., B.Sc., E. A. Lewis, Esq., B.Sc., Father G. A. MacDonald, B.A., H. R. Coish, Esq., B.Sc., J. R. F. Warr, Esq., B.Sc.

Papers: Steroids III. Observations on the Constitution of a New Keto-Lactone from the Urine of Pregnant Mares, by R. D. H. Heard and M. M. Hoffman. An Adiabatic Calorimeter for Determining the Heat Capacities of Metals from 100°C to 200°C, by L. G. Elliott. Demonstration: Hirschfelder's Scalar Atomic Models, by R. D. H. Heard.

6th Ordinary Meeting, April 8, 1940.

Papers: Further Studies on the Decomposition of Ethylidene Diacetate Homologues, by J. C. Arnell and C. C. Coffin. The Capillary Resistance Test, by C. B. Weld. Demonstration: Practical Uses in the Laboratory for Bromide Paper, by R. J. Bean.

Following the scientific meeting, refreshments were served and there was further informal discussion.

C. B. Weld,
Recording Secretary.

ABSTRACTS.

(Papers read before the Institute but not published in the Proceedings.)

The Carbohydrate Metabolism of Developing Salmon Eggs. Andrew Hollett, Fisheries Experimental Station (Atlantic), Halifax, N. S. (Read Nov. 13, 1939). Periodic estimations of the glucose and glycogen content of developing eggs and of egg fractions were made. It was found that all the carbohydrate in unfertilized and recently fertilized eggs was in the form of free sugar, and constituted less than 0.1 mg. per egg. Glycogen was first detected in the egg three weeks after fertilization. Except at hatching, there is an increase in glucose and glycogen with development, reaching a maximum in the larva about 65 days after hatching. The highest concentration of glucose was 0.33, and of glycogen was 0.53 mg. per egg. No glycogen was present in the yolk at any time during development. The liver begins to function as a storage place for glycogen about 40 days after hatching. From 60 to 70 days after fertilization, when the yolk is almost completely absorbed, the glucose and glycogen begin to decrease.

The Isolation of a New Androstanol-3(β)-One and of Allopregnanol-3(β)-One-20 from the Urine of Pregnant Mares. By R. D. H. Heard and A. F. McKay, Dept. of Biochemistry, Dalhousie Univ., Halifax, N. S. (Read Nov. 13, 1939). From the neutral fraction of equine pregnancy urine there has been isolated a new saturated hydroxy ketone, $C_{19}H_{30}O_2$, m.p. 187-187.5°, $[\alpha]_D^{24}$-160°, which is precipitated by digitonin and which forms an oxime, m.p. 194-195°, and a benzoate, m.p. 206-208°. Oxidation with chromic anhydride in the cold yields a diketone, m.p. 157-158°, not identical with androstanedione-3, 17. The parent hydrocarbon was obtained by Clemmensen reduction of the diketone and identified as androstane. The compound is therefore an androstanol-3(β)-one. Evidence is adduced that the carbonyl group is most probably located at C_6, C_7, or C_{12}. The occurrence of allopregnanol-3(β)-one-20, previously reported by Marker, has been confirmed.

Calyx and Structure of the Gravenstein Apple. Hugh P. Bell, Dept. of Biology, Dalhousie Univ., Halifax, N. S. (Read Dec. 11, 1939). The development and structure of the calyx end of the Gravenstein is compared with that of a number of other varieties. This comparison indicates:—(1) that the calyx end of the Gravenstein exhibits an unusual degree of variation in its mode of development; (2) that at maturity it is usually composed of a tissue which is exceptionally fissured and porous; (3) that most of these fissures and pores are radial slits; and (4) that, as these openings are so unusually large and numerous in the Gravenstein, its calyx end must be structurally weaker than the corresponding structure in the other varieties. It is suggested that the prevalence of open core in the Gravenstein is due to this structural weakness of the calyx end.

Permeability of the Eye Membrane. Hugh Davson and J. P. Quilliam, Dept. of Physiology, Dalhousie Univ., Halifax, N. S. (Read Dec. 11, 1939). The permeability of the membranes of the eye has been studied using an isolated head preparation. It is shown that the diffusion of potassium is apparently independent of secretory activity. The results are discussed in relation to the nature of the aqueous humour.

Fish Enzymes as Leather Bates. W. W. Johnston, Fisheries Experimental Station (Atlantic), Halifax, N. S. (Read Dec. 11, 1939). Factors governing the activity of fish enzymes are to be discussed. A comparison made between the enzymes of the pyloric caeca and fish intestine and those of hog pancreas showed that the former were just as satisfactory as the latter for use as leather bates.

The Oestrus-Inducing Gonadotrophic Substance II. A Comparison of the Infantile and Adult Rat Assays. R. D. H. Heard, Dept. of Biochemistry, Dalhousie Univ., Halifax, N. S. (Read Jan. 15, 1940). Standardization curves pertaining to the 21 day old rat have been constructed for comparison with those pertaining to the adult animal of the same strain. The parameters with their standard errors of the transformed dosage-response curves are: $m \pm s_m = 0.966 \pm 0.016$ and $b \pm s_b = 5.45 \pm 0.68$, for the infantile rat by the three injection technique of administration (262 animals), $m \pm s_m = 1.364 \pm 0.042$ and $b \pm s_b = 3.14 \pm 0.92$, for the infantile rat by the single injection technique of administration (210 animals), and $m \pm s_m = 0.525 \pm 0.009$ and $b \pm s_b = 8.72 \pm 1.03$ for the adult rat (561 animals—single injection), where m is the logarithm of the dose in micrograms required to elicit 50% of responses, and b is the slope of the regression curve. Hence, when 20 animals receive the standard preparation, and 20 of preparation being tested, and the response in both cases is 50%, the limits of error at $P = 0.99$ are respectively for the three test objects, 65 and 154%, 47 and 212%, and 76 and 131%.

Eastern Canadian Flat-Fishes. R. A. McKenzie, Fisheries Experimental Station (Atlantic), Halifax, N. S. (Read Jan. 15, 1940). This group of fishes yields a yearly catch of about seven million pounds with a value of three hundred and fifty thousand dollars. The halibut is responsible for about half the catch, two-thirds of this coming from offshore banks. The other half is made up of the landings of six different species with the larger proportion again coming from the offshore banks. This offshore catch consists of only four species in the main. There is much confusion in the many names applied to the various Flat-fishes and even the Fisheries Statistics of Canada lists only the halibut specifically and groups all the others under two indefinite headings, namely, Flounders, Brill and Plaice, and Soles. A recent survey has shown just what species are landed in the various districts from the different fishing grounds. Halibut (*Hippoglossus hippoglossus*) and Canadian Plaice (*Hippoglossoides platessoides*) may be caught both in and off shore all around the Canadian Atlantic coast. The Yellow Tail (*Limanda ferruginea*) and Witch (*Gluptocephalus cynoglossus*) are taken mainly on the Nova Scotian offshore banks. The Winter Flounder (*Pseudopleuronectes americanus*) is found everywhere in the Maritime waters, but is captured nowadays chiefly along shore, while the Smooth Flounder (*Liopsetta putnami*) landings are made mostly in the Gulf of St. Lawrence, with a few in the Bay of Fundy and none off outer Nova Scotia. The Greenland Halibut (*Reinhardtius hippoglossoides*) is a rare visitor from the north while the Summer Flounder (*Paralichthys dentatus*) is a very rare visitor from the south. The Brill (*Lophopsetta maculata*) is also southern in origin but it is found, though not abundantly, in a number of suitable areas in these waters. By rearranging the present Canadian Flat-fish Statistics in the knowledge of what species are landed in the various districts, it is found that in order of commercial importance, they rank as follows,—Halibut, Canadian Plaice, Yellow Tail, Witch, Winter Flounder, Smooth Flounder—the last two being of very little importance at present. Specimens of seven of the nine species of Flat-fishes are on display.

The Production of Dimethylamine in Cod Muscle Press Juice During Spoilage. V. K. Collins, Fisheries Experimental Station (Atlantic), Halifax, N. S. (Read Jan. 15, 1940). Dimethylamine is produced in spoiling cod muscle press juice before the appearance of trimethylamine, but in much smaller amounts than the latter.

Photo-dynamic Haemolysis. Hugh Davson and Eric Ponder, Dept. of Physiology, Dalhousie Univ., Halifax, N. S. (Read Feb. 12, 1940). Certain dye-stuffs are absorbed on to the surface of the erythrocyte and act as photo-sensitisers in a chemical reaction leading to the breakdown of the membrane. A special feature of this form of lysis has been investigated, and a theory has been put forward to account for it.

Steroids III. Observations on the Constitution of a New Keto-Lactone from the Urine of Pregnant Mares. R. D. H. Heard and M. M. Hoffman, Dept. of Biochemistry, Dalhousie Univ., Halifax, N. S. (Read March 11, 1940). The hitherto undescribed compound was isolated by way of the semicarbazone, $C_{20}H_{29}O_3N_3$, m.p. 210°. Hydrolysis of the semicarbazone yielded the free keto-lactone, $C_{19}H_{26}O_3$, $(\alpha_D)+70°$, m.p. 252°. Opening of the lactone ring was effected with dilute alkali to the corresponding hydroxy-keto-monocarboxylic acid, $C_{19}H_{28}O_4 \cdot \frac{1}{2}H_2O$, $(\alpha_D)+95°$, m.p. 220°, which gave a semicarbazone, $C_{20}H_{31}O_4N_3 \cdot \frac{1}{2}H_2O$, m.p. 270-272°, and a methyl ester $C_{20}H_{30}O_4$, m.p.

163-164°. Ring closure to the original lactone proceeded smoothly on distillation or treatment with mineral acid. Structure is discussed in the light of the above findings and the properties of degradation products.

AN ADIABATIC CALORIMETER FOR DETERMINING HEAT CAPACITIES OF METALS FROM 100° C TO 200° C. L. G. Elliott, Dept. of Physics, Dalhousie Univ., Halifax, N. S. (Read March 11, 1940). The specimen is heated electrically in an adiabatic all-copper jacket. The jacket is double walled, the outer wall of the jacket being automatically maintained 2° C below that of the inner wall. With this arrangement the heat losses from the inner wall are the same at all temperatures, so that the temperature difference between the specimen and the inside surface of the jacket is easily kept less than .002° C at temperatures as high as 200° C. The difficulties of insulation at these temperatures have been overcome by using glass insulated wire for the heating coils on the jacket and substances such as mica and asbestos for all other insulation. Results obtained with this apparatus are in complete agreement with values previously determined in the range 50° to 100° C.

FURTHER STUDIES ON THE DECOMPOSITION OF ETHYLIDENE DIACETATE HOMOLOGUES. J. C. Arnell and C. C. Coffin, Dept. of Chemistry, Dalhousie Univ., Halifax, N. S. (Read April 8, 1940). Previously reported studies on the effect of molecular structure on the velocity of monomolecular reactions have been extended. These studies are described and the results discussed in the light of modern theory.

THE CAPILLARY RESISTANCE TEST. C. B. Weld, Dept. of Physiology, Dalhousie Univ., Halifax, N S. (Read April 8, 1940). Pressure (Gothlin) and Suction (Dalldorf) methods are described in detail and typical results given in relation to purpura and scurvy. Different authors have frequently failed to agree in the interpretation of results and some reasons for discordant results are discussed. Vitamin D and activity of the sympathetic nervous system have previously been reported as affecting capillary fragility. Local changes in the degree of dilatation of skin capillaries are here shown to affect the test, and the extreme variation in the capillary resistance in different—even contiguous—regions of skin is stressed.

NOTICE TO AUTHORS.

To be printed in the volume of the year, a paper must be submitted for publication on or before the date of the May meeting.

Manuscripts should be typewritten (double spaced) on one side of the paper, $8\frac{1}{2}$ x 11 inches, with 1 to $1\frac{1}{2}$ inch margins. The original typewritten copy should be furnished.

An abstract, not over 200 words in length, must be placed at the beginning of the article. It should be suitable for reproduction in abstract journals. As an index, it should be complete; all the subjects, major and minor, concerning which new information is presented, should be mentioned. As a summary, the abstract should give briefly the conclusions of the article, important advances in experimental technique and in theory, and numerical results of general interest. For an excellent type of abstract see "The Physical Review". A summary at the end of the article should be omitted since it is included in the abstract.

Citations to the literature and notes will be placed at the bottom of the page and should be indicated in the text by superscript numerals, numbered consecutively from 1 up. All footnotes should be collected on a separate manuscript page for the benefit of the printer. The form of citations should be as indicated by the following examples:

[1]Thomson, *Phil. Mag.*, [7] **3**, 241 (1927).

[2]Bachem, *Arch. exptl. Path. Pharm.*, **122**, 69-76 (1927); C.A., **22**, 274 (1928). No reference should be cited which has not been consulted by the author himself. When only an abstract is available, it should be indicated in the citation as in the second case above. In abbreviating journal titles employ standard abbreviations used in such well-known abstract journals as "Chemical Abstracts". In citing books, use the form shown in the following example:

[3]Mellor. "*Inorganic and Theoretical Chemistry,*" Longmans, Green and Co., London. **1923**, vol. 4, pp. 625, 645.

In constructing tables arrange them to leave as little waste space as possible. All drawings intended for reproduction should be made about twice the size of the proposed cut on white paper or on tracing linen. They should be drawn with extreme care, preferably by a draftsman. Material in each figure should be arranged compactly. It is well where possible to make the longer dimension horizontal. All lines that are to be reproduced must be sufficiently heavy to be clearly legible in the finished cut. When coordinate paper is used, it should be printed in blue only, with the important lines ruled over in black; the black squares in general should be not less than ten millimeters on a side in the printed cut. The lettering of cuts, when reduced, should be about the size of the letters in the text. The Institute bears the expense of a limited number of cuts only. Where necessary half-tones for reproduction on special paper will be accepted at the author's expense.

Unless page proofs are specifically asked for, galley proofs only are sent to the author for correction. Proofs should be corrected with great care and returned by next mail to the Editor, Dr. Harold S. King, Dalhousie University, Halifax, N. S.

The Institute furnishes the author of each paper with 50 reprints without covers gratis. Additional copies may be obtained at reasonable rates if applied for at the time of return of the proof to the Editor. If covers to reprints are desired, an extra charge is made.

PRINTED
IN CANADA

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

Museum of Comparat. Zoolog.
JAN 2 1942
LIBRARY

VOL. XX. 1940-1941 PART 3

CONTENTS

Barytes Deposit at Pembroke, N. S. A. E. Cameron 57
The Ferns of Nova Scotia. A. E. Roland 64
The Ascorbic Acid Content of Some Maritime Province Foods. B. C. Collier, M. F. M. Morrison and M. E. Morse 121
Some Recent Aspects of Genetics. R. R. Gates 127
Presidential Address. H. S. King 141
Proceedings of Meetings. Session of 1940-41 149
Abstracts. (Papers read before the Institute but not published in the Proceedings.) 153

Editor: Ernest Hess
Editorial Board: E. G. Young and G. H. Henderson
Printed for the Institute by The Imperial Publishing Company Limited
Date of Publication: December 18, 1941

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1940-41
(Vol. XX, Part 3)

6253

Museum of Comparative Zoology
JAN 24 1942

BARYTES DEPOSIT AT PEMBROKE, HANTS COUNTY NOVA SCOTIA

A. E. Cameron, Deputy Minister
Department of Mines, Province of Nova Scotia

(Received July 5th, 1941)

ABSTRACT

Exploration by surface trenching and diamond drilling have outlined a body of over 1,000,000 tons of high grade, light red color barytes in Paleozoic sediments near Pembroke, Hants County, Nova Scotia. The deposit is restricted to a subsidiary synclinal fold on the north limb of a broad syncline and appears to be due to replacement of an iron rich calcareous series of sediments representing either the base of the Windsor formation or the top of the Horton formation.

Introduction

The south shore of Minas Basin between the Avon River at Windsor and the Shubenacadie River at Maitland has long been known as a potential source of mineral wealth. It attracted the attention of the early geologists and in the past has produced considerable tonnages of manganese and gypsum and, even, some barytes. Depletion of ore in surface and near surface deposits resulted in a dwindling production until today the only working deposits are the National Gypsum Company's quarries at Walton. The region is heavily drift covered, making prospecting exceedingly difficult and costly, and limiting the operations of the ordinary prospector. Outcrops of bed rock are few and scattered, being confined almost entirely to the seashore and the floors of the small sharp valleyed streams. The general rock structure is indicated by the areal geology, but detailed structures which can be expected to control ore depositions are hidden by the drift and require subsurface evidence to delineate. Moreover, the known minerals are for the most part not the precious or heavy metals, such as gold, lead, zinc and copper, which have been the cause of exploration and the source of the great new mineral production of Canada in recent years. They are largely the common earthy minerals which, though of prime importance to our civilization, do not have the same lure and fascination for the prospector and miner. They enter a highly competitive market, with rigid specifications and, generally, because the cost of preparation far exceeds the cost of primary production, only high grade, easily accessible deposits are worked. They are a processing rather than a mining problem. It is, therefore, not to be wondered at that the deposit of barytes now in process of development at Pembroke has not been worked heretofore, although its surface outcrops were first noted over forty years ago, and although it lies within one mile of the abandoned workings of a manganese mine from which a considerable production of that metal was obtained at the end of the last century.

Barytes was mined in Nova Scotia as early as 1874 from a deposit at Five Islands on the north shore of Minas Basin (Poole 1875). The first record of the presence of the mineral at the present site is given by Selwyn (1895), who states, "barite in considerable quantity occurs in veins in limestone at Walton and Pembroke". The exact site of the present workings was marked on the map published by Fletcher (1905). The economic possibilities of this deposit, however, were not recognized until McKee examined the outcrop in 1940.

GEOLOGY

The regional geology of the area, studied by Logan, Selwyn and Fletcher, was first compiled into a map by Fletcher in 1905. The whole region is heavily drift covered, recent drill records showing thickness up to 75 ft. of glacial gravels and tills. Bed rock consists of carboniferous limestone, sandstones and shales, for the most part stained with iron, and thus showing arid conditions of deposition. Gypsum beds are not infrequent and several saline springs are scattered throughout the area. Triassic sandstones and conglomerates with remnants of amygdaloidal flows and cut by basic dykes are exposed close to the shore of Minas Basin.

Era	Period	Formation	Lithology
Cenozoic	Recent	River and lake deposits	Silts and sands
	Pleistocene	Ground moraines	Gravels and boulder clays
		UNCONFORMITY	
Mesozoic	Triassic		Lava flows, basalt and diabase dykes, etc.
			Sandstones and conglomerates
		UNCONFORMITY	
Paleozoic	Carboniferous	Windsor—	Sandstone, shale, Limestone, gypsum
		Horton—	Shale, sandstone conglomerate

The Horton-Windsor contact appears to be the most important or significant geological feature of the area. The general arid condition of deposition at that time resulted in a widespread distribution of iron throughout the sediments. At the same time earth movements resulted in rapid changes, both in the extent of the sea and in the character of the sedimentation in the sea. Horton sandstones are replaced by shales and shaley limestones in rapid succession both vertically and laterally. At the beginning of Windsor times the seas cleared somewhat, but embayments were cut off by land changes and evaporation from these bays resulted in precipitation of calcium carbonate and calcium sulphate from the saturated sea waters.

The general structure of the region is a broad syncline, striking northeast, and pitching to the east. The axis of the syncline is well south of the area under consideration, so that in the vicinity of the barytes deposit the bed rock trends northeasterly, and dips to the south. Local changes in dip are common and there are undoubtedly many minor structures superimposed on the major structure, but these have not yet been worked out in detail. It will be shown later that the barytes bed is clearly related to such a secondary structure and there is good reason to believe that the same condition will hold for the manganese ore bodies. The detailed study now being made of the barytes deposit may lead to a determination of features which will be a decided help in a further search for manganese in the area.

The primary structures are presumably due to broad earth movements that occurred at the close of Permo-Carboniferous period. The secondary structures may be contemporaneous, or, and more probably are, the result of movements in Triassic times associated with the lava flows and basic intrusions that make up North Mountain of the Annapolis Valley and the similar rocks exposed along the north shore of Minas Basin. The mineral deposits, both manganese and barytes, appear to be replacements of certain beds or portions of beds by percolating solution, but whether they were of supergene or hypogene origin remains to be proved. One is inclined to think that the primary source of these metals can most logically be placed to the igneous activity of the Triassic, although they may have been transported to their present positions by surface waters.

BARYTES DEPOSITS AT PEMBROKE

As previously stated, the examination of the Pembroke barytes deposit was commenced in October, 1940. The deposit outcropped on the crest of a low ridge and was exposed for an area of a few square feet only. Systematic trenching and pit digging outlined an area of 200 feet square with barytes at depths of not over 5 feet from the surface. A composite sample taken from these trenches showed the barytes to be of exceptionally good quality, although stained somewhat by iron. An aggressive exploration by diamond drill has proceeded throughout the winter and a large body has now been proven.

The trend of the ore body is fairly definitely known and its general form is outlined. Further drilling is required before the full size of the deposit will be known and detailed knowledge of the character and quality of the whole mass must await complete study of the many feet of drill core obtained. The information available at present is factual only, but certain deductions can be made which may or may not be proved by further studies.

The drilling operations completed to date show clearly that the barytes occupies a sharp synclinal fold which strikes east and west and pitches east at an angle of about 28°. The axis of this secondary structure may be conformable with or is obliquely angular to that of the major structure. The dense, relatively insoluble barium sulphate in its synclinal position has resisted erosion and solution so that the upper end of the pitching syncline has been left at the surface to form an elongated hill.

The ore body occurs in and appears to be limited to an iron rich calcareous series of sediments where they are caught in the secondary syncline. This series consists of interbedded calcareous sandstones, limy shales and impure limestones. Variations in character of sedimentation show both vertically and horizontally. Roof rocks of the series have not yet been definitely determined. Pavement consists of a persistent thin bed of impervious grey argillite overlying a bed of grey sandstone.

Cores of all the holes have shown angular portions and thin layers of sandy red shales and red sandstones enclosed in the barytes. There is no apparent continuity of these but they appear at different horizons in different holes. There is thus considerable evidence to show that the deposits are formed by replacement of an iron rich calcareous material. The persistent sandy character of the remaining fragments indicates a tendency towards selective replacement or lime-iron rich portions, leaving silica rich portions incompletely replaced.

The barytes makes a gradational contact with underlying feruginous calcareous sandstones. The cores of the holes show gradually increasing content of red sandy fragments until the majority of the core appears as a barytes impregnated material. A sufficient number of the holes have cut the pavement material to establish the position of this horizon. The most easterly hole shows increasing quantities of sandy fragments within the barite zone.

We may summarize the evidence obtained to date in the statement that, it tends to indicate that this barytes deposit is a replacement deposit formed by descending supergene solutions percolating down through an iron rich calcareous series of sediments and replacing the lime rich portions of that series with barium sulphate. Descent of the solution appears to have been restricted to a secondary synclinal structure superimposed upon the broad general structure of the region.

As stated previously, information to date indicates a very substantial quantity of barytes. With the eastern extension still unproven, calculations show well over a million tons now blocked out by drilling. Throughout all the cores quality is generally good; specific gravity determinations made on random pieces of core average better than 4.3 and a composite sample from the thirteen (13) surface trenches—after washing—averaged 4.41.

Chemical analysis shows:

Barytes	($BaSO_4$)	97.1%
Lime	(CaO)	0.1
Ferric Oxide	(Fe_2O_3)	0.8
Silica	(SiO_2)	1.1
Not determined		0.9
		100.0%

Markets and Uses

The immediate present day market for this material is as a component in circulating drilling fluids used in the British West Indies oil fields. The finely ground barytes (-300 mesh) is used with bentonite and a dispersing medium in water suspensions in the drill hole. The heavy fluid so formed, weighing about 120 lbs. to the cubic foot (1.93 S.G.), acts both as a liquid seal against gas and oil pressures encountered when the oil sands are pierced by the drill and as a means of removing rock cuttings from in front of the rotating bit of the drill.

Specifications for barytes for this use are strict, both as to fineness of grinding and specific gravity. Normal specifications are:

Screen analysis	98% through -300 mesh
Specific Gravity	4.15—4.25
Water soluble content	less than 2%

From the analysis already quoted it can be seen that, if milling operations of the Pembroke barytes are satisfactory, it should have no difficulty meeting this specification.

Editor's Note: Since presentation of this paper before the Institute on April 7, 1941, development of the barytes deposit has proceeded rapidly. A mill was erected at Walton, Nova Scotia and was placed in operation by the middle of May. First shipment was made to Trinidad on June 14. Average specifications for this shipment was as follows:

Barium sulphate	96.85 %	
Specific Gravity	4.42	
Water Soluble	0.127	
Screen Analysis	99.005	through 325 mesh (Tyler)

A complete description of mining and milling operations at this deposit was presented to the Nova Scotia Mining Society at its annual meeting, Pictou, Nova Scotia, June 25, 1941.

REFERENCES

Fletcher, Hugh. Map No. 879, Walton Sheet No. 74, 1 inch—1 mile, Geological Survey of Canada, 1905.

Poole, H. S. Ann. Rep. for 1874. Nova Scotia Dept. of Mines, p. 57, 1875.

Selwyn, A. R. C. Geol. Survey of Canada for 1892-93, p. 66A, 1895

THE FERNS OF NOVA SCOTIA

A. E. Roland, Provincial Botanist
Nova Scotia Agricultural College
Truro, N. S.

(Received June 10th, 1941)

Abstract

This paper summarizes our knowledge of the ferns of Nova Scotia. The work of previous botanists in the area is mentioned; and the general distribution of the ferns is discussed. A total of 43 species, 7 additional varieties and 12 forms are mentioned as occuring in the province. Keys are given for the various groups; and each species, variety or form is briefly described and its habitat, range and abundance noted.

Introduction

The ferns, because of their beauty and limited number, invariably first attract the attention of the botanist, and probably no other group of vascular plants in our flora is quite so well known. Nevertheless they still present many difficulties to the student in respect to their distribution, variability and taxonomy; and the published records relating to the ferns of this province are scattered through many publications and botanical journals. It is the aim of this article to present in brief form our knowledge of these plants.

One of the first amateurs who studied the ferns was the Rev. E. H. Ball, who records most of the common forms from Guysborough, Rawdon, and Mahone Bay. His records, (Ball 1876) together with those of Prof. How of King's College, Windsor, Principal A. H. MacKay of Pictou Academy, and Dr. Lawson and Dr. Lindsay of Halifax, form the basis for the ferns in A. W. H. Lindsay's "Catalogue of the Flora of Nova Scotia" published in the "Proceedings" of this Institute in 1876.

Dr. George Lawson extended his studies to cover the ferns of Canada, and his "Fern Flora of Canada" was long used in the schools as an appendix to the botany book. His variety *Mackayii* of the common Fragile Fern was first published in this work, and several other common varieties bear his name.

Other collectors who were active around 1900 were the Dominion Botanist, J. Macoun, who made numerous trips to the province, and C. B. Robinson of Pictou.

During the last thirty years the local botanists have been almost entirely inactive. Fortunately, however, our knowledge of the flora of the extreme northern and southern parts of the province has been enriched by two detailed studies by outside specialists. The vegetation of Northern Cape Breton was studied in detail by Dr. G. E. Nichols of Yale University, who spent four summers in this district. During the summers of 1920 and 1921 an expedition from Gray Herbarium of Harvard University, headed by Prof. M. L. Fernald, worked in the southwestern part of the province from Digby around to Queens County. Both of these parties published numerous observations on the ferns, which have been of great value in making up the habitat and proper distribution of the various forms.

Nova Scotia is not rich in ferns; a total of 43 species, 7 additional varieties, and 12 forms are listed in this paper. Several species, mentioned below, may be expected yet in the province, and minor forms or varieties are doubtless present.

Geologically and climatically the province consists of two main divisions. The south and southwestern part of the province, comprising roughly a region south of a line from Digby to Musquodoboit Harbour with much of Richmond and Cape Breton Counties, has a higher precipitation, and the land is relatively low and flat and heavily glaciated. Consequently the soil is thin, acid, and poorly-drained; innumerable lakes, bogs and streams occur, and the forest is mainly coniferous. The northern part of the province from Annapolis to Cumberland and northern Cape Breton has much more diverse topography and better soils, and originally was covered with a hardwood forest. Here occur limestone and gypsum outcrops, rich intervales and deep rocky ravines.

The ferns may be divided, roughly, into four groups according to their distribution. The southern half of the province contains mainly the ferns of barrens, swamps or of mixed woods that grow anywhere in poor soil throughout the whole province, such as *Athyrium angustum*, *Dryopteris cristata*, *Pteridium*, *Dryopteris spinulosa* var. *intermedia*, *Polypodium* and *Polystichum acrostichoides*. An occasional one such as *Dryopteris Bootii*, and *Botrychium dissectum* and its forma *obliquum* become gradually rarer eastward.

The northern part of the province, however, with its richer soils and woodlands possesses numerous ferns that are extremely rare or entirely absent in the southern region. *Botrychium virginianum* and *Pteretis nodulosa* are found in rich intervales or woods throughout the region. *Crytopteris bulbifera* and *Adiantum pedatum* are found about the occasional outcrops of gypsum and limestone in woods and ravines. Along the Bay of Fundy, in the Cobequids, and in the hardwood areas of Inverness and Victoria Counties the richer woodlands are characterized by *Polystichum Braunii* and *Dryopteris spinulosa* var. *americana*. The ravines, cliffs, and talus slopes may possess *Woodsia ilvensis*, *Cystopteris fragilis*, *Asplenium Trichomanes*, and in the more northern part, *Dryopteris fragrans* var. *remotiuscula*.

In addition to these plants with a general distribution depending mainly on soil and climate, two other groups of ferns occur whose distribution seems to depend somewhat on geographical history.

In southwestern Nova Scotia three ferns occur which seem related to the Coastal Plain element of our flora. *Woodwardia areolata* is restricted to the river-systems of the Tusket, Clyde and Roseway Rivers, and is not found elsewhere east of Massachusetts. *Woodwardia virginica* is common in the southwestern counties, scattered eastward to Halifax, with an extension northward to the ponds around the Minas Basin. *Schizaea pusilla* in the bogs and sphagnous hollows forms a connecting link between the pine barrens of New Jersey and the unglaciated tablelands of Cape Breton and Newfoundland.

At the opposite end of the province are found a number of plants which are distributed around the Gulf of St. Lawrence, and elsewhere only in limestone regions about the Great Lakes, or common westward in the Rocky Mountains. The three ferns best characterizing this group have not been found on the mainland and are: *Dryopteris filix-mas*, a fern also common in eastern Europe; *Polystichum lonchitis*, whose distribution is contrasted with that of *Woodwardia areolata* in Map 2; and *Cystopteris fragilis* var. *laurentiana*.

The keys to the genera and species are all dichotomous so that two choices are always present. Each of the pair of statements, which may be widely separated, are indicated by the same letter; and another letter at the end of the statement indicates to what pair next to proceed.

The scientific names used are in agreement with the latest International Rules of Botanical Nomenclature. No attempt has been made to give all the synonyms, but a short history of the name is usually given so that its relation to other names may be seen. A conservative attitude has been adopted towards the splitting of the genera and the creation of new species. In many cases, where the fern is frequently found under a different category, the alternate name is given. Names of the authorities are abbreviated as in Broun, *Index to North American Ferns* (1938), and all references to the synonymy and the history of the naming of each fern up to the year 1938 can be found in this index.

Of the ferns and fern allies which belong to the group known as the *Pteridophytes*, only the true ferns have been considered. The following synopsis gives the four families which are found in the province.

FAMILIES OF FERNS

Polypodiaceae—

Large herbaceous plants with the fronds coiled in the bud; sporangia borne on the back of slightly modified vegetative fronds, or on the inside of tube or berry-like structures formed by the inrolled or coiled parts of the frond, long-stalked, with a ring of thickened cells, the annulus, arching over the top and tearing it open transversely at maturity, usually covered by an indusium.

Schizaeaceae—

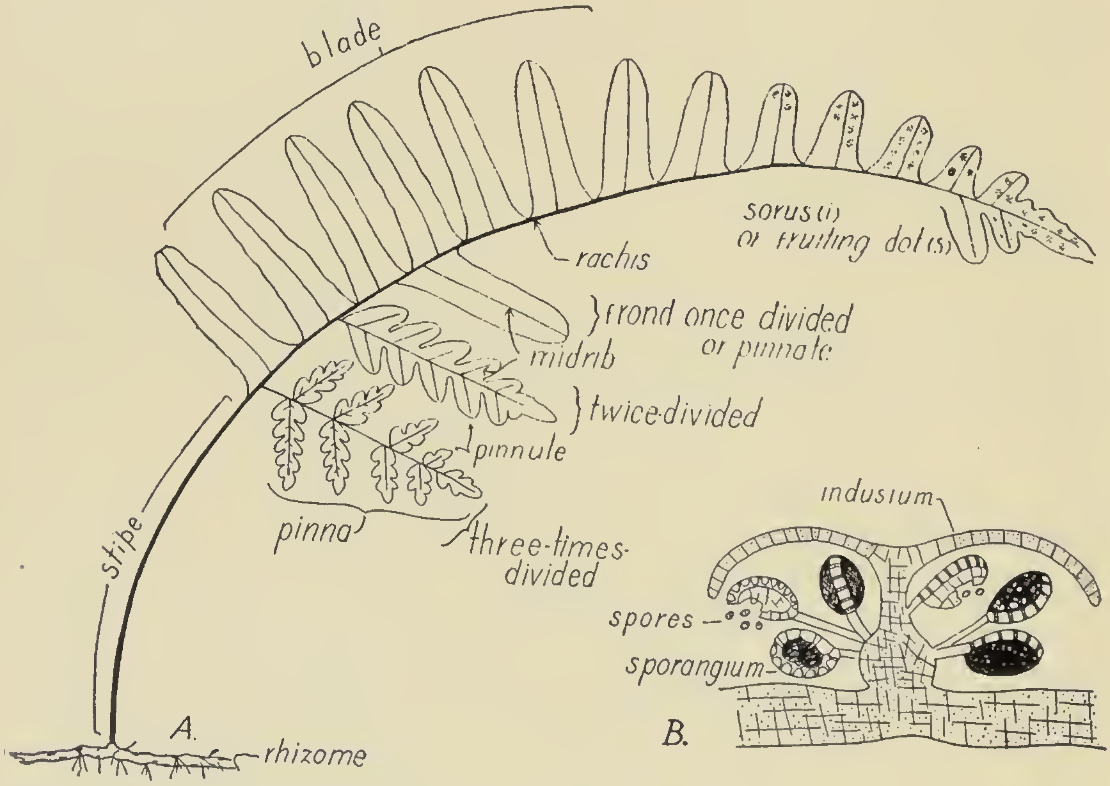
Small twining or tufted plants, our representative 3-7 cm. high; sporangia borne in double rows along the pinnae, with a transverse ring at the apex, and opening vertically by a longitudinal slit.

Osmundaceae—

Large plants with stout creeping rootstocks; sporangia borne on completely fertile fronds or parts of the frond, short-stalked, without an indusium, and without an annulus or only a trace of one, opening by a longitudinal slit.

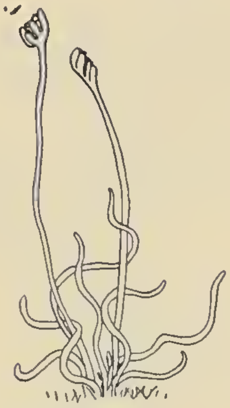
Ophioglossaceae—

Rather fleshy plants with fleshy roots; leaves folded in the bud; sporangia borne on a specialized branch arising from the base of the sterile blade, without an indusium or annulus, and sessile or nearly so.

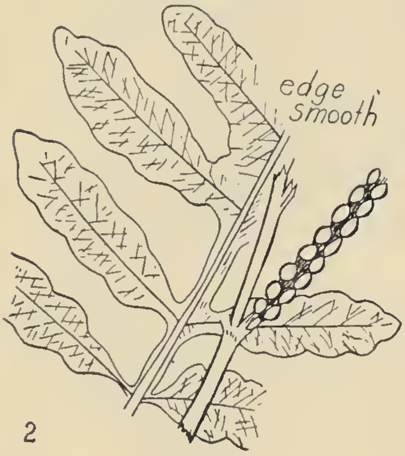


A. Diagram to show the different parts of a fern, and the types of pinnae found in different plants; B. a section down through a single sorus (*Dryopteris* or *Polystichum*), much enlarged.

KEY TO THE COMMON FERNS AND FERN GENERA OF NOVA SCOTIA



1



2

a. Plants with the sporangia on fronds or pinnae that are very different from the sterile green ones, b.

b. Modified fruiting pinnae and sterile pinnae only on separate fronds, c.

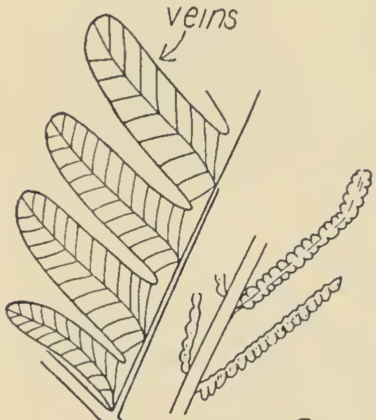
c. Sterile fronds simple or once-divided only, d.

d. Sterile fronds thread-like; fertile fronds one-sided, 4-7 cm. high; rare.

Schizaea (p. 107)

d. Sterile fronds 3-6 dm. high, not divided to the midrib, and with a smooth margin; fertile fronds with sporangia enclosed in bead-like rolled pinnae.

Onoclea (p. 99)

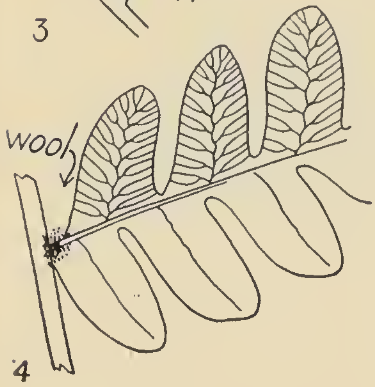


3

c. Sterile fronds twice-divided, 3-9 dm. high; growing in large clumps, e.

e. Sterile fronds with veins of pinnules not forked; fertile fronds plume-like, with the sporangia in long rolled pinnae.

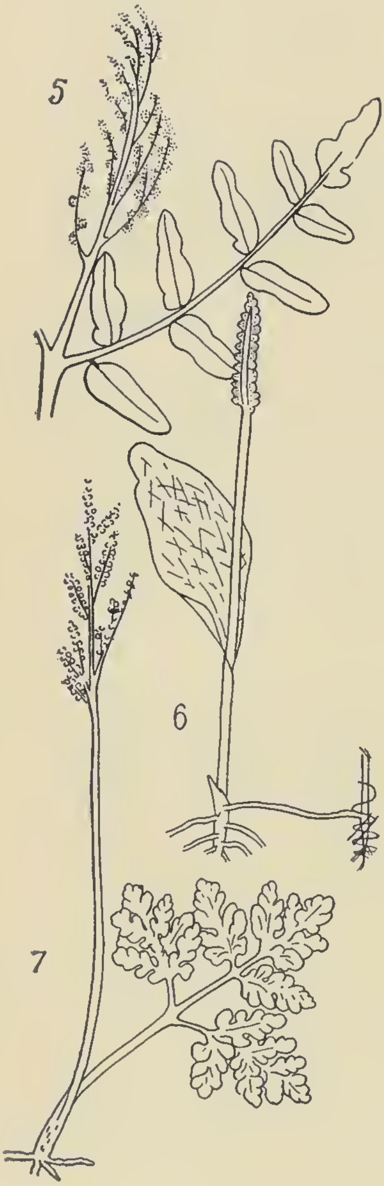
Pteretis (p. 100)



4

e. Sterile fronds with veins of the pinnules forked; each pinna with a tuft of rusty wool at its base; woolly-brown fertile fronds appearing in early summer and soon disappearing.

Osmunda cinnamomea (p. 110)



b. Modified fruiting pinnae occurring on the same frond as the sterile pinnae, f.

f. Fronds 5-15 dm. high, in large clumps from stout woody rhizomes, g.

g. Fruiting pinnae only in the middle of the frond; pinnules as in O. cinnamomea but without the wool at the base.

Osmunda Claytoniana (p. 111)

g. Fruiting pinnae at the top of the frond; pinnules large and separated at the base.

Osmunda regalis (p. 108)

f. Fronds rarely over 5 dm. high, usually growing singly from soft, delicate rhizomes, h.

h. Sterile portion ovate with a smooth margin and netted veins; fertile part a simple spike, arising from the base of the blade.

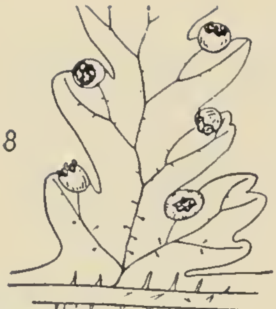
Ophioglossum (p. 111)

h. Sterile portion more or less divided, often 3-parted, with forking veins; fertile part paniculate, often almost separate from the leafy part.

Botrychium (p. 112)

a. Plants with the sporangia on the underside of slightly or not at all modified divisions of the frond, i.

i. Sporangia protected by an indusium consisting of, or associated with the inrolled margin of the frond. (This is obscure in the case of the next) j.

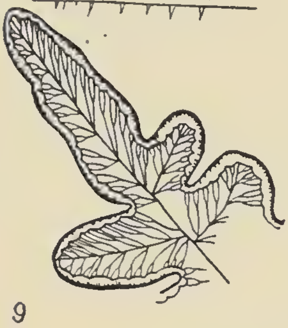


8

j. Frond soft-hairy; indusium cup-like and very small, attached beneath the sporangia; very common.

Dennstaedtia (p. 83)

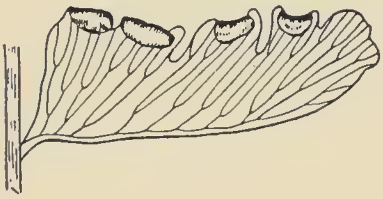
j. Frond smooth; fruiting sori covered by the inrolled margin, k.



9

k. Frond large, with 3 main divisions; sporangia in a continuous line. Our common bracken.

Pteridium (p. 74)



10

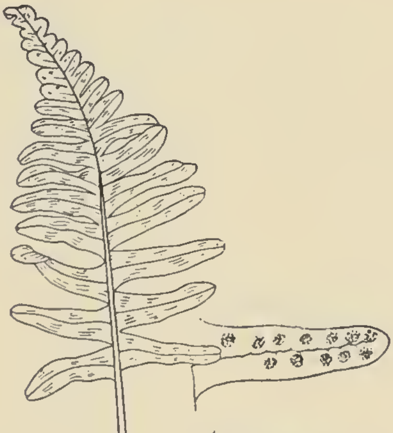
k. Frond repeatedly forking; each separate group of sporangia protected by an inturned lobe of the margin.

Adiantum (p. 75)

i. Sporangia not protected by an indusium; or else covered by one which is not associated with the edge of the frond, l.

l. Fruiting dots or sori rounded, m.

m. Fronds once-divided only; evergreen, n.

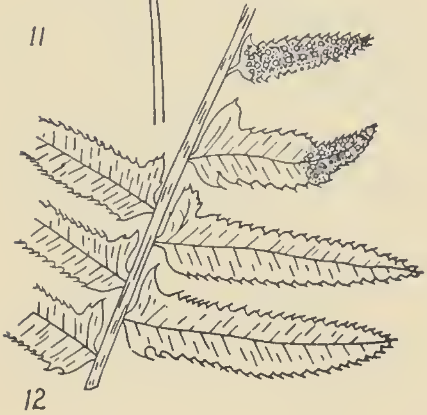


11

n. Edge of the pinnae not toothed.

Polypodium (p. 74)

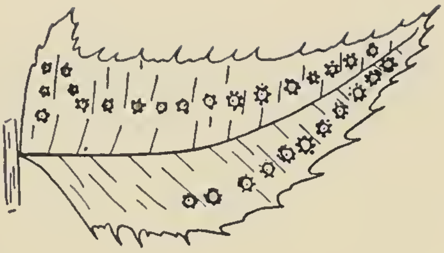
n. Edge of the pinnae toothed, o.



12

o. Fruiting pinnae smaller than the sterile ones; sori very crowded.

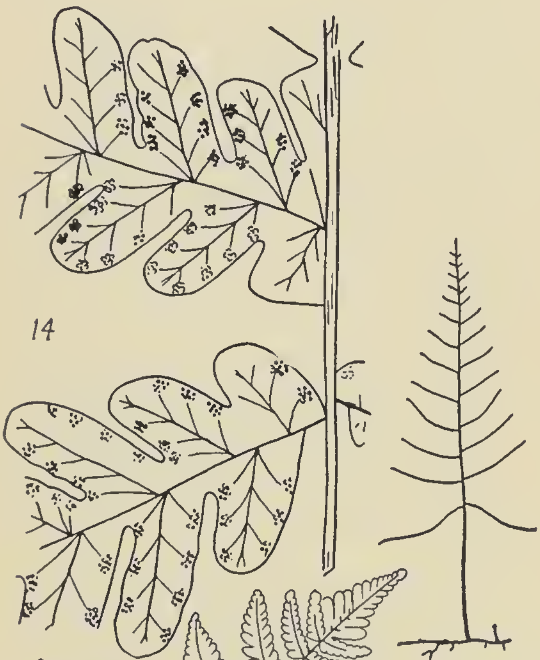
Polystichum acrostichoides (p. 84)



13

o. Fruiting pinnae not smaller than the sterile ones; sori separated.

Polystichum Lonchitis (p. 86)



14

m. Frond twice or more divided, p.

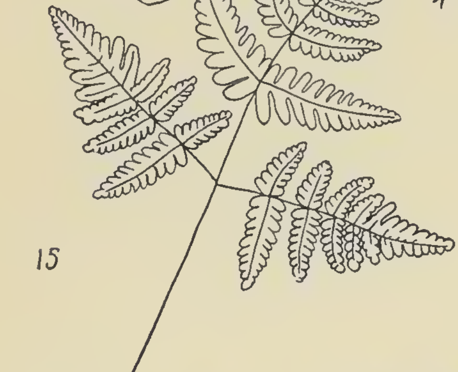
p. Sori not protected by an indusium; ripe forms may be mistakenly placed here but the following two are quite distinct, q.

q. Frond hairy, thin; pinnae joined by a wing along the rachis; the lower two being reflexed.

Dryopteris Phegopteris (p. 91)

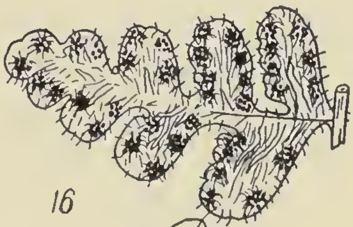
q. Frond smooth, divided into three nearly equal divisions.

Dryopteris disjuncta (p. 91)



15

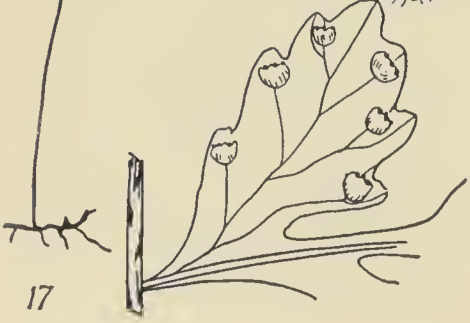
p. Sori protected by an indusium, r.



16

r. Fronds small, 5-15 cm. long, covered with rusty chaff; stipe jointed near the base; indusium attached beneath the sorus and evanescent.

Woodsia ilvensis (p. 104)

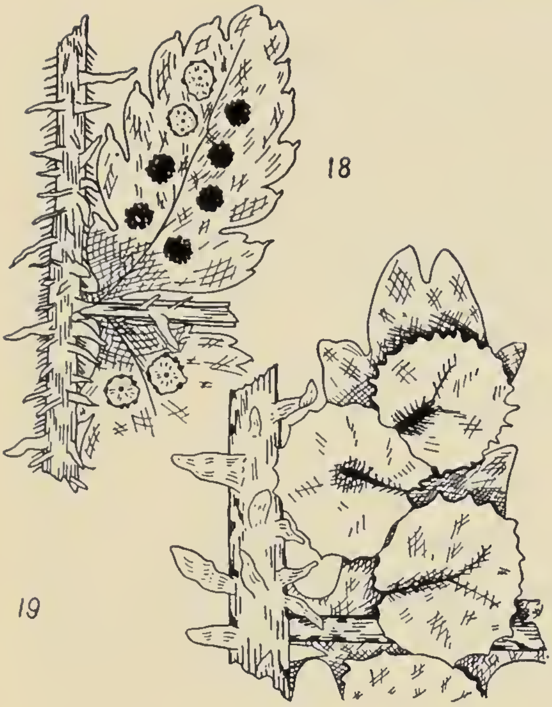


17

r. Fronds not as above, s.

s. Frond very thin and delicate; indusium attached at the base and delicate; damp woods and moist cliffs only.

Cystopteris (p. 101)


18

19

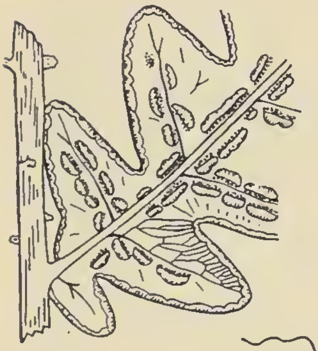
s. Fronds larger and coarser; indusium round, attached at the centre or at a notch, t.

  t. Indusium attached at the centre; frond thick and chaffy; rich woods, Blomidon northward.

Polystichum Braunii (p. 85)

  t. Indusium attached at the notch, round or kidney shaped; fronds various.

Dryopteris (p. 86)


20

l. Fruiting dots and indusia oblong or linear, u.

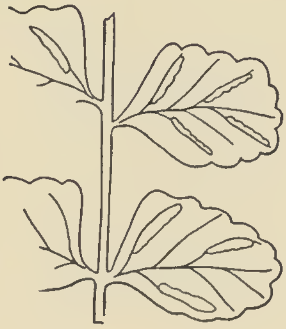
  u. Sori and indusia parallel to the rachis and mid-rib of the pinnae.

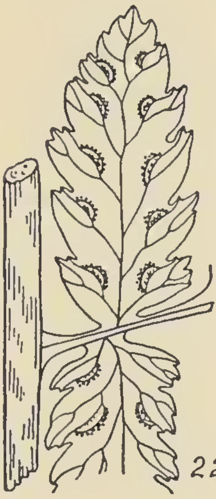
Woodwardia (p. 76)

  u. Sori and indusia not parallel to the rachis and mid-rib of the pinnae, v.

    v. Fronds 5-15 cm. long, once - divided, with rounded pinnae; cliffs, rare.

Asplenium (p. 79)


21


22

    v. Fronds 30 - 100 cm. long, twice - divided; common.

Athyrium (p. 80)

POLYPODIACEAE Fern Family

POLYPODIUM (Tourn.) L.

Rootstocks covered with brownish scales, creeping, with the stipes jointed plainly to it; fronds deeply lobed only; sori round, arranged on the back of the lobes, without an indusium.

Rock Polypody

P. virginianum L. Fig. 11.

Linnaeus recognized an European *Polypodium vulgare* and an American *P. virginianum.* The American plant was long known under the European name but the distinctness of the two plants is now coming to be accepted. The differences were treated in detail by Fernald. Fernald, M. L. *Polypodium virginianum* and *P. vulgare.* Rhodora. 24:125-142. 1922.

Frond 1-3 dm. long; blade about as long as the stipe, 3-5 cm. wide, and tapering to the tip, deeply divided with the lobes very shallowly toothed; veins forking with the ends projecting on the upper surface and clearly visible.

The Polypody is one of our most common and best known ferns. It is recognized by its thick dark-evergreen fronds with the smooth-edged undivided pinnae. It is common throughout the province on damp rocky cliffs, boulders, wooded banks and ledges, occasionally growing directly on the soil but preferring a rocky substratum with leaf mold shallowly over it.

Newfoundland to Alberta south to Georgia and Arkansas.

PTERIDIUM Scop.

Rootstock extensively creeping and branched; fronds ovate, or in our east-American form large and three-parted with the three divisions much divided; sporangia continuous around the edge of the divisions, protected by the inrolled margin and a delicate, inner inconspicuous indusium.

Bracken

P. aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw. Fig. 9.

The European plant was named *Pteris aquilina* by Linnaeus. Because it has a delicate inner indusium, and differs in the complicated structure of the stipe and the presence of hairs instead of scales on the rootstock, it was separated off as *Pteridium* by Kuhn and the American variety was later named var. *latiusculum.* [*P. latiusculum* (Desv.) Hieron]. Tryon, R. M., Jr., Revision of the Genus *Pteridium.* Rhodora. 43: 1-31, 37-67. 1941.

Frond 3-15 dm. long; blade 2-8 dm. long, broadly triangular, and usually three times divided; pinnules deeply lobed with oblong rounded divisions.

The large nearly horizontal, triangular fronds of the Bracken and its wide distribution make it one of the best known ferns in the world. It is common throughout the province in pastures, barrens, waste land and burnt-over areas; and, since it spreads rapidly by its long root-stocks, colonies can often be seen invading pastures or along the edge of deserted fields. Found on rather light soil, and often associated with wire birch and sweet fern.

Scattered plants are often found in which the blade is ovate instead of ternate, the segments of the frond are minutely hairy around the margin and more densely so beneath the margin and mid-rib, and the sterile indusium is ciliate. This form is intermediate between var. *latiusculum* and var. *pubescens* and has not yet been satisfactorily interpreted. Tryon states that "There is considerable evidence that they are merely the results of adverse growing conditions such as burning, pasturing, and extremes of exposure and soil sterility".

Newfoundland to Alberta south to Georgia and Arkansas.

ADIANTUM (Tourn.)L.

Rootstock wiry, much branched and creeping; sporangia borne on the under side of the upper lobes of the pinnules;

inturned lobes papery and reflexed to form a protective indusium over the sori.

Maidenhair Fern

A. pedatum L. Fig. 10.

Named by Linnaeus on material sent to him from Canada and Virginia.

Frond 2-6 dm. high; stipe smooth and shining, purplish-brown; blade horizontal, 2-4 dm. wide, with the rachis several times forking and the lower branches recurved, round or semicircular in outline; pinnules oblong to fan-shaped, short stalked, smooth on the lower margin, and cleft along the upper edge with the recurved fertile lobes.

The Maidenhair Fern although seldom found, is one of the best known ferns of the province. It is exceedingly rare, and is found only in very rich woods or about gypsum or limestone areas. I have seen collections from Yarmouth Co.; Canaan, Kings Co.; Clarksville and Scotch Village in Hants Co.; and East Mountain in Colchester Co. It was early reported from Newport and Upper Musquodoboit, and Professor Harlow of the Agricultural College, Truro, tells me that he has seen it near a limestone quarry in northern Cape Breton.

Nova Scotia to Minnesota south to Georgia, Louisiana and Oklahoma; eastern Asia.

WOODWARDIA J. Sm.

Rootstock stout and widely creeping; fronds all alike, or with the fertile much narrowed; sori oblong to linear, borne on the back and parallel to the midrib of the pinnae or of the pinnules. Plants of wet habitats or swamps.

The following two species are here placed in the genus *Woodwardia.* Owing to slight differences, however, they are often separated and each placed in a genus of its own.

a. Frond twice-pinnate, both the fertile and the sterile one alike. (See Fig. 20) 1. *W. virginica*

a. Frond pinnate only, with the fertile frond much narrowed and more erect. 2. *W. areolata*

Chain Fern

1. *W. virginica* (L.) J. Sm. Fig. 20 Map 1.

This fern was named *Blechnum virginicum* by Linnaeus in 1771 and J. E. Smith placed it in the genus *Woodwardia* in 1793. Presl founded the new genus *Anchistea* for it in 1851 and if the plant is considered sufficiently distinct the name is consequently *Anchistea virginica* (L.) Presl.

Fronds 6-10 dm. high, 15-20 cm. wide; stipe 2-4 dm. long, smooth and black at the base; blade twice-pinnate with the pinnules smooth-edged, and the veins forming a single row of areoles near their base; sori oblong, arranged in rows on either side of the mid-rib of the pinnules near the apex of the frond.

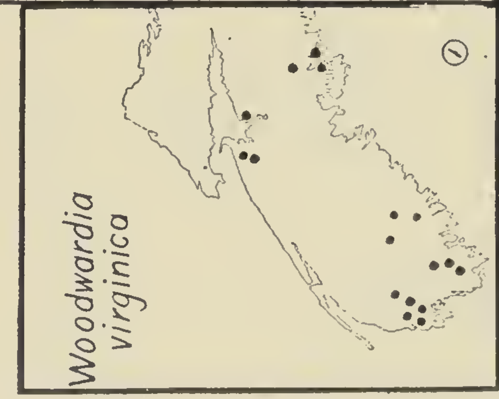
The Chain Fern is very distinctive when fruiting, and it may be easily distinguished from the *Osmundas* and *Pteretis* in the sterile state by the anastomosing veins. It is characteristic of swampy woods, boggy shores, swamps, and cobbly lake-shores in Yarmouth, Shelburne and Queens Counties. From there it is scattered eastward to Halifax and up to Kings County. It is reported from P. E. I. but the northeastern limits of its range in N. S. seem to be at the Northwest Arm and Waverley in Halifax County, and at Cheverie, Lily Lake in Centreville, and the ice-pond at Kentville around the Minas Basin. It is common at the side of the paved road along the first muddy pond on the Bedford-Waverley Road.

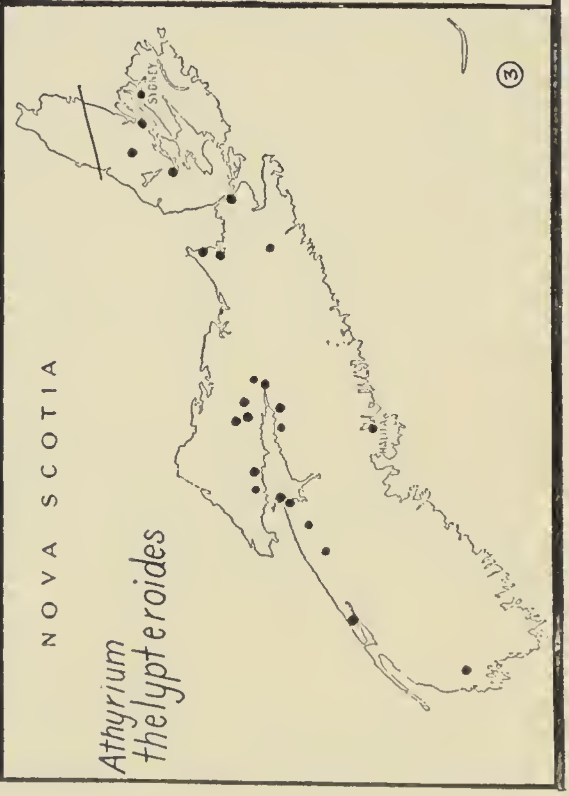
A coastal plain plant ranging from Florida to Texas, northward to Long Island and Nova Scotia and rarer inland to Ontario and Michigan.

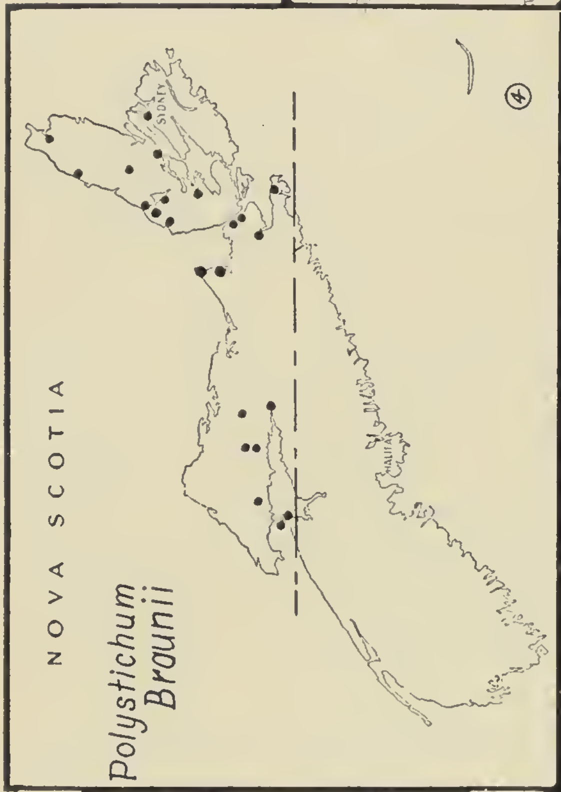
Dwarf Chain Fern

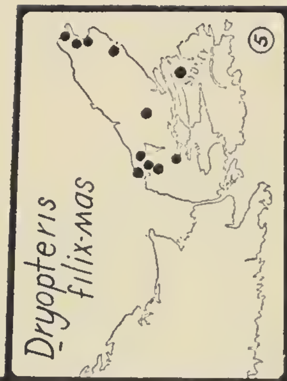
2. *Woodwardia areolata* (L.) Moore. Map 2.

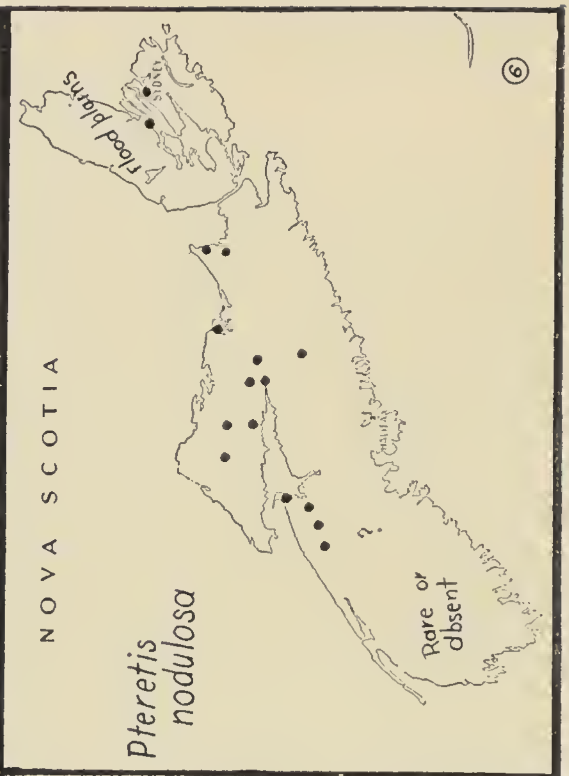
Linnaeus named this fern *Acrostichum areolatum* with specimens from Maryland and Virginia and Moore placed it in the genus *Woodwardia* in 1857. Presl founded the genus


Woodwardia virginica
①
HALIFAX


NOVA SCOTIA
Athyrium thelypteroides
③
SYDNEY
HALIFAX


NOVA SCOTIA
Polystichum Braunii
④
SYDNEY
HALIFAX


Dryopteris filix-mas
⑤
SYDNEY


NOVA SCOTIA
Pteretis nodulosa
⑥
flood plains
SYDNEY
HALIFAX
?
Rare or absent

Lorinseria at the same time that he separated the preceeding and this plant is frequently called *Lorinseria areolata* (L.) Presl.

Rootstock slender and creeping; sterile fronds spreading, 3-6 dm. long, 10-15 cm. wide; stipe about as long as the blade; blade deeply lobed with the lobes acutely tipped, and their margin very finely serrate, and with the veins freely anastomosing; fertile frond erect and surpassing the sterile, with the lobes but 3-5 mm. wide and with a double row of indusia on the lower side.

The Dwarf Chain-fern may be confused with the Sensitive Fern, but it is easily distinguished by the finely-toothed margin of the sterile blades and by the very different fertile fronds.

It is found only in Yarmouth and Shelburne Counties, where it is rather local. It is especially well-developed along the upper limits of the Clyde and Roseway river systems where it is found in swamps, wet woods, and the margins of bogs.

Florida to Texas and northward along the coast to Massachusetts and Nova Scotia, rare inland to Missouri and Michigan.

ASPLENIUM L.

Our native species are small ferns, with the blade once-divided, with rounded pinnae; sori linear and straight, with the indusium attached along one edge.

Key to Species

a. Rachis shining-purplish; fronds wiry and stiffer.
1. *A. Trichomanes*

a. Rachis greenish; fronds thinner, more delicate.
2. *A. viride*

Maidenhair Spleenwort

1. *A. Trichomanes* L. Fig. 21.

Named by Linnaeus from European material and the wide-spread American plant shows no essential differences.

Frond 8-20 cm. long, 0.6-1 cm. wide; stipe short, both it and the rachis dark shining-purplish; blade once-divided; pinnae orbicular, mostly opposite, and shallowly toothed, each with 2-8 linear sori on the lower side.

A pretty and very distinctive fern. Rare; found on damp shaded cliffs near running water. Specimens are present from Melanson, Kings Co.; Moose River, Cumberland Co.; and Hartley's Waterfall on the Strait of Canso. It was earlier reported from the Look-Off, Kings Co., near Halifax, Canso and Gold River (near Chester). Common, Big Intervale, C.B.

Nova Scotia to Alaska south to Georgia and Arizona; Europe and Asia.

Green Spleenwort

2. *A. viride* Huds.

Named by Hudson in 1762. The European and American plant are the same.

Fertile and sterile fronds alike, growing in tufts, 8-12 cm. long, 1-2 cm. wide; stipe brownish at the base, to green above; rachis green; blade linear-lanceolate and once divided; pinnae ovate, mostly opposite and toothed.

The Green Spleenwort and the Maidenhair Spleenwort are much alike, although the former is a more delicate fern with thinner fronds. They both grow in similar locations on damp cliffs and both are among the rarer ferns of the province. MacKay (1906) states that this fern was collected at the falls, Moose River, Cumberland County about 1890; and at River Deny's Cave, Cape Breton, by Robinson in 1902. I have not seen specimens from these locations, but Mr. Weatherby tells me that there is a good specimen in the Gray Herbarium collected by Macoun at Big Intervale, Cape Breton, July 22, 1898.

Newfoundland and Nova Scotia west to Wisconsin and northwestward to Alaska.

ATHYRIUM Roth

Rootstocks short and stout; fronds large and twice-divided, with forked veins; sori linear-oblong, often curved, borne along a small vein at an angle to the main vein of the pinnule; indusium attached along one side.

Key to Species and Forms

a. Sori and indusia straight and silvery when immature; pinnules rounded at the tip or with rounded blunt teeth, b.

b. Pinnules with straight sides and rounded tip; margin undulate or but slightly toothed.

1. *A. thelypteroides*

b. Pinnules with curved sides and slightly pointed tips; margin more coarsely toothed.

2. *A. thelypteroides* forma *acrostichoides*

a. Sori and indusia often curved and not silvery; pinnules pointed at the tip with irregular sharp teeth, c.

c. Fronds of two kinds, the fertile thicker, more leathery in texture; sori at maturity running together and covering the lower surface of the fronds, d.

d. Longest pinnae of the fertile frond 5-12 cm. long; pinnules 4-12 mm. long, with the sori mostly straight; pinnules of the sterile frond oblong and rounded, and but slightly toothed or lobed.

3. *A. angustum*

d. Longest pinnae of the fertile frond 1-2 dm. long; pinnules 12-15 mm. long, with the sori often horse-shoe shaped; pinnules of the sterile frond oblong-lanceolate, somewhat pointed, and strongly toothed or lobed.

4. *A. angustum* var. *elatius*

c. Fronds all alike, the fertile ones almost membranaceous; sori separate at maturity; pinnules as in Fig. 22

5. *A. angustum* var. *rubellum*

Silvery Spleenwort

1. *A. thelypteroides* (Michx.) Desv. Map 3.

First named *Asplenium acrostichoides* by Schwartz in 1801 and two years later *Asplenium thelypteroides* by Michaux The present combination was made by Desvaux in 1827. The name *Athyrium acrostichoides*, which was first given it in 1899, is not legitimate because another plant had been given this name long before. Some botanists consider this fern more closely related to the tropical genus *Diplazium* than to *Athyrium*; the name is then *D. thelypteroides* (Michx.) Presl.

Frond 4-7 dm. long; 12-20 cm. wide; stipe and rachis smooth to finely chaffy; blade lanceolate, twice-divided, broadest near the base and tapering to a long tip, usually minutely chaffy on both sides.

The Silvery Spleenwort is best recognized by the silvery sheen of the straight indusia and the sterile fronds have characteristic long tapering pinnae and oblong blunt pinnules. It is common in rich woods, very rare in the southwestern counties, scattered through the Annapolis Valley, common in Colchester and Cumberland Counties, and in rich or calcareous woods from there to northern Cape Breton.

Nova Scotia to Minnesota south to Missouri and Georgia.

2. Forma *acrostichoides* (Sw.) Gilbert is a luxuriant form characteristic of richer locations. Characteristic specimens were collected from a rich run on the side of Cape Blomidon and some of the plants from the Cobequids are more luxuriant and toothed than usual.

Lady Fern

3. *A. angustum* (Willd.) Presl.

Linnaeus named the Lady Fern of Europe *Polypodium Filix-femina.* Material from Canada was named *Aspidium angustum* by Willdenow in 1810 and his species was transferred to *Athyrium* by Presl in 1825. Until recently our plant was referred to the European name but it is now considered distinct. The varieties were revised by Butters in 1917. Butters, F. K., The Genus *Athyrium* and the North American Ferns allied to *A. Filix-femina*, Rhodora. 19:170-207. 1917.

The typical form of the species has fronds 3-8 dm. long and 8-20 cm. wide, with the fertile fronds more contracted and leathery in texture than the sterile; stipe smooth or almost so; blade lanceolate, widest above the base; pinnae widest at the base and tapering to a slender tip; pinnules only shallowly toothed with the sori at maturity covering the lower surface.

This is less common than var. *rubellum* but is scattered through the province. It is really a sun form and may be found in open moist situations, in pastures and along roadsides.

Nova Scotia to Manitoba south to Iowa and Pennsylvania.

4. Var. *elatius* (Link) Butters.

This variety is a larger form with more finely divided fronds and longer pinnae. The pinnules are 12-25 mm. long, sharply and deeply toothed, much more pointed at the ends, and with the sori rather round and running together at maturity. It seems to prefer rich moist soil, and when growing in partial shade is difficult to distinguish from large forms of var. *rubellum.*

Fernald (1921, 1922) has reported it from Lunenburg and Yarmouth Counties and typical material was also seen from Colchester and Guysboro.

Nova Scotia to Maine and Maryland west to Wisconsin.

5. Var. *rubellum* (Gilbert) Butters. Fig. 22.

This is our common variety, and it is frequent throughout the province along roadsides, in pastures, moist thickets, swamps and open woods. Typical var. *rubellum* is distinguished from the other varieties by having the fertile and sterile fronds alike, and the sori widely separated even at maturity. Since, however, the three forms grade into each other, a proportion of the specimens will be difficult to identify exactly.

Newfoundland to Manitoba south to Colorado and Virginia.

DENNSTAEDTIA Bernh.

Rootstocks creeping; veins forked; sori small, with the sporangia protected by a cup-like indusium joined to an inturned toothlet of the pinnule.

Hay-Scented Fern

D. punctilobula (Michx.) Moore. Fig. 8.

Michaux discovered this fern in Canada and named it *Nephrodium punctilobulum* in 1803. Later it was transferred to a tropical genus as *Dicksonia punctilobula* (Michx.) Gray and this genus was split finally, leaving the tree-like forms under *Dicksonia* and the herbaceous forms in *Dennstaedtia*.

Frond 3-8 dm. long, 8-15 cm. wide; stipe smooth; blade lanceolate, widest at the base, twice-divided, minutely hairy and glandular; pinnae lanceolate; pinnules oblong, doubly toothed, with small inconspicuous sori attached near the base of the upper margin of each lobe.

The Hay-scented Fern is best recognized by the thin finely-cut, glandular-hairy fronds. The rootstock creeps and branches extensively so that this fern usually grows in large matted clumps. It is found mostly on dry hillsides and slopes, especially about hummocks and rock piles, and is characteristic of our upland pastures and hillsides throughout the province. Frequent also in open or dryish woods, roadsides, and rarely in swamps. Unpalatable to animals, and often becoming a weed in sterile pasture-land.

Nova Scotia to Minnesota south to Georgia.

POLYSTICHUM Roth

This genus comprises in eastern America three species which are large and evergreen, with stout rootstocks, round sori and round indusia attached at the centre.

Christmas Fern

P. acrostichoides (Michx.) Schott. Fig. 12.

This fern was first named *Nephrodium achrostichoides* by Michaux in 1803 and was placed in the genus *Polystichum* by Schott in 1834.

Frond 3-7 dm. long, 8-15 cm. wide; stipe covered with chaffy scales; blade leathery and evergreen, lanceolate, pinnate only; pinnae also lanceolate in outline, auricled on the upper side at the base, and spiny-toothed; sori crowded on much smaller pinnae near the tip of the blade.

The Christmas Fern is one of the commoner ferns in moist woods, on wooded banks, and thickets throughout the whole province.

Nova Scotia to Ontario and Wisconsin south to Texas and Florida.

Forma *incisum* (A. Gray) Gilbert is a form with the pinnae deeply toothed. This seems to be a common, luxuriant form found in rich soil; and often forms grading between this and the typical form can be found in the same woods.

Braun's Holly Fern

P. Braunii (Spenner) Fee, var. *Purshii* Fernald. Fig. 18. Map 4.

The European fern was first described as *Aspidium Braunii* by Spenner in 1825, and placed in the genus *Polystichum* by Fee in 1852. The American plant, long considered identical, was separated by Fernald. Fernald, M. L., The eastern American variety of *Polystichum Braunii.* Rhodora 30:28-30. 1928.

Fronds in circular clumps, 3-10 dm. long, 8-15 cm. wide; stipe very chaffy; blade rather leathery, widely lanceolate, tapering at both ends, twice pinnate, and chaffy beneath and on the rachis.

The Holly Fern is one of our most beautiful ferns, very graceful when found in the woods, and easily recognized when seen. It is typical only of our richest hardwood areas. Common on Cape Split and about the sides of Cape Blomidon; Victoria Park, Truro; Moose River, Folleigh Lake, and Earltown, Colchester Co.; Pirate Cove, Guysboro Co.; and common from Whycocomagh and Mabou northward in Cape Breton.

Robinson (1904) says of it "Local on the mainland 'it' here becomes abundant in the hill district and in the north becomes a splendid plant often exceeding four feet in height". Nichols (1918) lists it as characteristic of the deciduous climax forest, sandy flood plains, and especially of ravines in northern Cape Breton.

Newfoundland to northern Wisconsin, southward into the uplands of New England and New York, northeastern Pennsylvania; also in Alaska.

Holly Fern

P. Lonchitis (L.) Roth. Fig. 13. Map 2.

Described as *Polypodium lonchitis* by Linnaeus in 1753, and placed in the present genus by Roth in 1799.

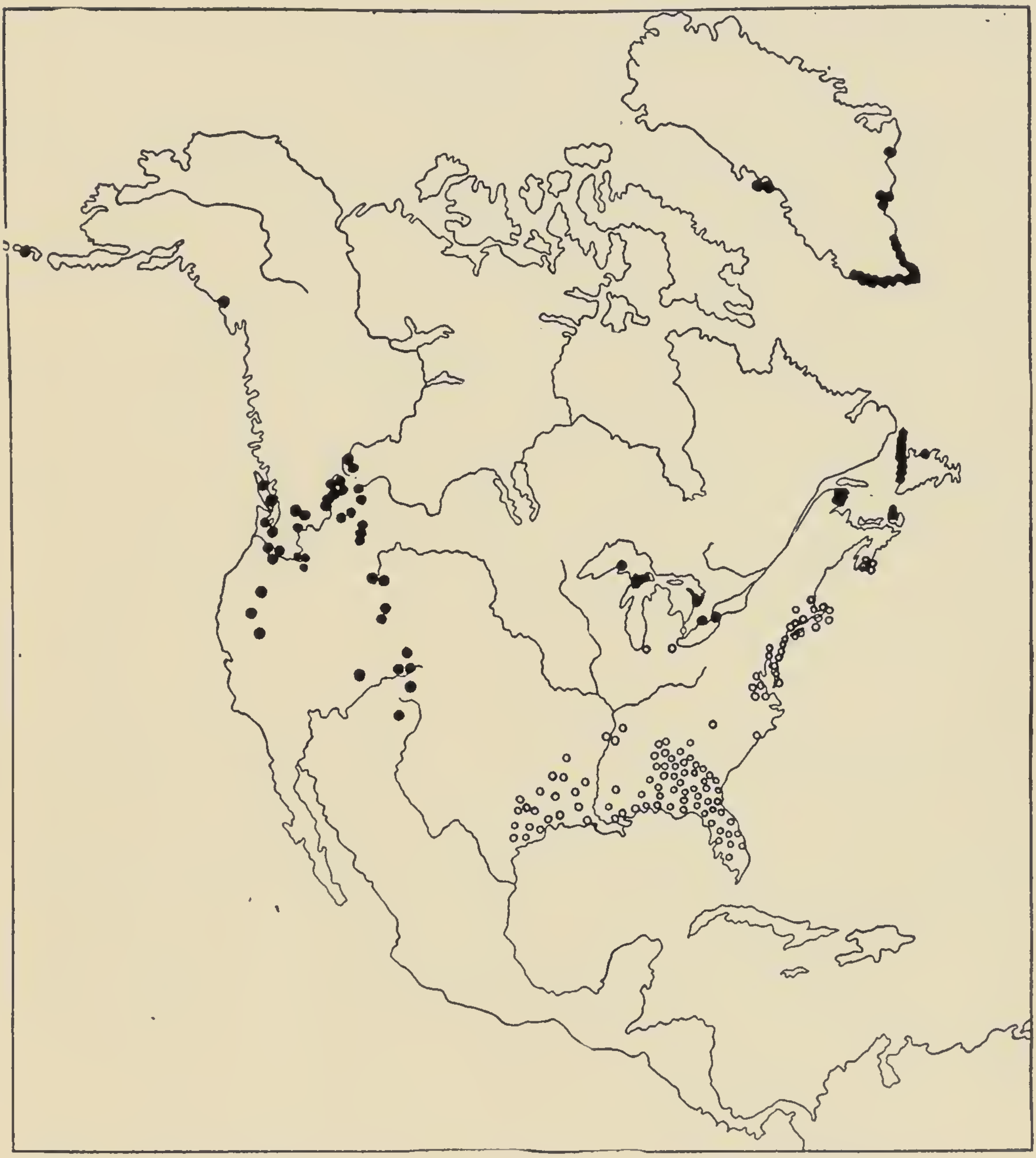
Fronds in clumps, from stout rootstocks; stipe short with scattered broad scales; blades 2-6 dm. long, 4-6 cm. wide, tapering at each end and rather scythe-shaped, but once-divided with the pinnae auricled on the upper side near the base and sharply toothed; sori in two rows on the backs of the upper not-reduced pinnae.

This is one of the rarest ferns in eastern Canada. It is a northern plant which occurs on the rock-talus slopes at the base of shaded cliffs, usually on limestone. Known in the province only on Cape Breton Island. In considerable abundance at Aspy Bay (Macoun 1883-90); River Deny's Cave, and along the roadside near the top of Glencoe Mountain (Robinson 1904).

This is an excellent example of a group of "relic" species which have a peculiar disrupted eastern range and which indicate a relationship to the Rocky Mountain flora. The range in eastern America is on limestone, as in Cape Breton, Newfoundland and the Niagara Peninsula; or else in the very richest woods, as on the Keweenaw Peninsula in Michigan.

DRYOPTERIS Adans.

The ferns here included have at different times been placed in such genera as *Aspidium*, *Lastrea*, *Phegopteris*, *Thelypteris*, and *Dryopteris*. At the present time the genus is often divided into the three genera: *Thelypteris*, *Phegopteris*, and *Dryopteris*. However, since the first and third have intergrading species in the tropics, and the status of the second has not yet been finally settled, all are placed in the same group



Map 2. Range of *Polystichum Lonchitis* (dots), and *Woodwardia areolata* (circles) to show the distribution of a northern plant found only in northern Cape Breton, and a coastal plain plant occurring in southwestern N. S. Data from maps published by Fernald in Rhodora. **37**: 207. 1935 and **33**: 55. 1931.

with the alternate names given for those who wish to keep the three sections in separate genera.

Key to Species

a. Indusium absent or present; fronds thin, not evergreen, with its smallest divisions obscurely toothed or with a smooth margin, and the veins simple or only once-divided; stipe nearly smooth, b.
  b. Frond lanceolate in outline; pinnae not stalked, c.
    c. Indusium present, d.
      d. Blade with the lower pinnae as long as the middle one, e.
        e. Veins of the sterile fronds mostly forked.

1. *D. Thelypteris*

        e. Veins of the sterile fronds mostly simple or unforked.

2. *D. simulata*

      d. Blade with the lower pinnae gradually decreasing in size.

3. *D. noveboracensis*

    c. Indusium absent

4. *D. Phegopteris*

  b. Frond triangular in outline with three almost equal divisions; lower pinnae stalked.

5. *D. disjuncta*

a. Indusium always present; fronds thicker. often evergreen, with the divisions toothed or variously cut; veins twice-forked or more; stipe more or less chaffy or with numerous scales, f.
  f. Fronds small, up to 25 cm. long and 5 cm. wide; resinous, with the teeth of the pinnules blunt.

6. *D. fragrans* var. *remotiuscula*

  f. Fronds much larger and not resinous, g.
    g. Scales at the base of the stipe numerous and linear, h.
      h. Sori near the margin; pinnules not sharply toothed at their tip.

7. *D. marginalis*

      h. Sori not on the margin; pinnules minutely and sharply toothed, especially at the tip.

8. *D. filix-mas*

    g. Scales at the base of the stipe ovate or oblong, i.
      i. Frond bi-pinnate; or partly tri-pinnate near the base. j.
        j. Indusium glabrous or smooth.

9. *D. cristata*

j. Indusium minutely glandular.

10. *D. Boottii*

i. Fronds tri-pinnate or nearly so.

11. *D. spinulosa*

SECTION LASTREA

Marsh Fern

1. *Dryopteris Thelypteris* (L.) A. Gray, var. *pubescens* (Lawson) A. R. Prince ex Weatherby.

This fern is an Eurasian plant described by Linnaeus and placed in the present genus by Gray. The common American fern, which differs especially in its pubescent fronds, was first described by Lawson. Under *Thelypteris* the name is *T. palustris* Schott, var. *pubescens* (Lawson) Fernald. Fernald, M. L., A Study of *Thelypteris palustris*. Rhodora. 31:27-36. 1929.

Fronds 4-5.5 dm. long, 8-13 cm. wide; stipe as long or longer than the blade, smooth; blade widest near the base, twice-divided, lightly pubescent; pinnules wavy-margined with the veins mostly forked; fertile fronds with the sori densely crowded and the margin of the pinnules inrolled, taller and narrower than the sterile ones.

Common throughout the province along ditches, damp roadsides, etc. It does not grow in water, but in open muddy meadows it may grow over large areas as thickly as grass.

Newfoundland to Manitoba, south to Georgia and Oklahoma.

Forma *suaveolens* (Clute) A. R. Prince ex Weatherby, is a fragrant form reported from New Hampshire, and from near Baddeck.

Massachusetts or Bog Fern

2. *Dryopteris simulata* Davenp.

Discovered and named by Davenport in 1894. (*Thelypteris simulata* (Davenp.) Nieuwl).

Fronds 3-5 dm. long, 6-10 cm. wide; stipe nearly as long as the blade; blade narrowly lanceolate, twice-divided, with the veins of the sterile fronds mostly unbranched; fertile fronds narrower and longer, the pinnae often folded along the midrib, and with the edge of the pinnules inrolled.

This fern is very like the Marsh Fern in appearance, but it is narrower in outline and is best distinguished by the simple veins. In habitat it is also intermediate between the last and the next, for it grows in situations too shady for the Marsh Fern and too wet for the New York Fern.

In Nova Scotia it is found in swales and wet thickets, knolls in peaty barrens and in sphagnous spruce bogs, local and somewhat general from Yarmouth County eastward to Lunenburg County; and at Mount Uniacke in Hants.

This is a coastal plain species ranging from southwestern Nova Scotia to Alabama, and sporadically inland to Prince Edward Island, southernmost Quebec, New York and West Virginia.

New York Fern

3. *Dryopteris noveboracensis* (L.) A. Gray. (*Thelypteris noveboracensis* (L.) Nieuwl.)

Fronds 4-8 dm. long, 8-15 cm. wide; stipe short; blade thin, lanceolate, and long-tapering at each end, nearly twice-divided; pinnae longest in the middle of the frond, the lowest being mere auricles; pinnules oblong, slightly pointed, flat, and with simple veins; sori small, numerous and separate.

The New York Fern is easily recognized by the thin light-colored fronds which taper to the base, and by the unbranched veins. It is common throughout the province, being usually abundant in dry, shady woodlands and along shady roadsides and fences, but seldom persisting in open sunlight or in wet meadows like the Marsh Fern.

Newfoundland to Minnesota south to Georgia and Arkansas.

Long Beech Fern

4. *Dryopteris Phegopteris* (L.) C. Chr. Fig. 14.

Linnaeus first described this species and later it was separated off into a new genus and became *Phegopteris phegopteris.* Since a duplicate name was not desirable it was given the name *P. polypodioides* Fee. It was first placed in *Dryopteris* by Christensen in 1905.

Frond 2-5 dm. long, 8-15 cm. wide; stipe as long or longer than the blade; blade triangular, finely hairy and chaffy, especially on the rachis and veins beneath, nearly twice-divided; pinnae widest at the middle, all but the lowermost pair connected to the others by a wing along the rachis, the lowermost deflexed; pinnules oblong, wavy-margined, with the naked sori separate near the edge.

This fern is distinguished by its short triangular blade, deflexed lower pinnae, and naked sori. It is common throughout the province in rich cool woods, on shaded hillsides, and especially on damp or dripping cliffs and in ravines near running water.

Newfoundland to Alaska south to the Gulf States.

SECTION GYMNOCARPIUM

Oak Fern

5. *Dryopteris disjuncta* (Rupr.) Morton. Fig. 15.

The Oak Fern was originally described as *Polypodium Dryopteris* by Linnaeus and has been variously known as *Phegopteris Dryopteris* (L.) Fee, *Thelypteris Dryopteris* (L.) Slosson, and *Dryopteris Dryopteris* (L.) Christ. In order to avoid the double name, Christensen, 1905, proposed the name *Dryopteris Linnaeana* which was generally accepted; but the above earlier name has since been found. The relationship and proper position of the Oak Fern is as yet obscure. Morton C. V. On the Name of the Oak Fern. Rhodora 43: 216-219. 1941.

Frond 1.5-4 dm. long; stipe 2-4 times the length of the blade; blade thin and green, not glandular, twice-pinnate, triangular and with three main divisions, the lower two pinnae being stalked and much larger than the others.

This fern is quite distinctive with its small, smooth, bright-green ternate blade. It is common in rocky or dryish hardwoods throughout the whole province.

Newfoundland to Alaska south to New Mexico and Virginia.

Dryopteris disjuncta (Rupr.) Morton, forma *erecta* (Lawson); n. comb. *Polypodium Dryopteris* var. *erectum* Lawson, in Edinburgh New Phil. Journ. 19: 109 (repr. 10). 1864.

Forma *erecta* is a tall stout form which grows in rich shady places; frond rigid and erect; stipe very stout and not glandular; lower pinnae little larger than the upper ones. Lawson (1889) says that this form grows around the shores of Bedford Basin and the Basin of Minas, and also in beech woods at Collin's Bay, near Kingston, Ontario.

D. Robertiana (Hoffm). C. Chr. is a very similar appearing fern which differs in having the fronds glandular and the pinnae sessile so that the frond does not appear to be three-parted. This has been collected in the Maritimes only in New Brunswick, but it is to be expected on the limestones and gypsums in northern Cape Breton.

SECTION EUDRYOPTERIS

Fragrant Fern

6. *Dryopteris fragrans* (L.) Schott, var. *remotiuscula* Komarov. Fig. 19.

The species is essentially an arctic plant. The southern plant, which may be an adaptation to more favourable conditions, was named var. *Hookeriana* by Fernald while these ferns were temporarily in the genus *Thelypteris*. This variety name was later found to be preceded by the above, based on Eurasian material in 1911.

Frond 4-25 cm. long, 2-4 cm. wide, glandular, and sparingly chaffy, the dead fronds coiled and resinous; stipe very short; frond twice-pinnate, lanceolate; pinnae separate, widest near the base and rounded at the tip; pinnules oval to oblong, with blunt teeth, each with one or two sori with very large brown indusia.

The Fragrant Fern is quite distinct from any other fern, and is recognized by its resinous fragrant fronds, small size, and large indusia. It is likewise one of the rarer ferns of the province and for many years was known only as very rare and inaccessible on the cliffs at Hartley's Waterfall, on the Strait of Canso. Nichols (1918) listed it as one of the plants especially characteristic of cliff crevices along streams in northern Cape Breton, growing with *Polypodium*, *Cystopteris fragilis*, and *Woodsia ilvensis*. It is also found on the rocky cliffs of Moose River, near Parrsboro, associated with the same ferns.

Newfoundland to New York west to central Minnesota and in Eastern Asia.

Marginal Shield Fern

7. *Dryopteris marginalis* (L.) A. Gray. Fig. 23, 24.

Described from Canadian material by Linnaeus in 1753.

Frond 3-6 dm. long, 10-15 cm. wide; stipe chaffy, very densely so at the base, with golden linear scales; blade leathery and evergreen, twice-pinnate, lanceolate and widest near the base, nearly smooth and of a bluish-green color; pinnae tapering to a long tip; pinnules oblong or longer, with shallow rounded teeth and compact round sori at the margin.

The Marginal Shield Fern is known by its leathery blade of a characteristic color, by the marginal sori and by its linear basal scales on the stipe. Common in rocky woods and shady slopes throughout the centre and eastern part of the province, and characteristic of the hardwood forests in Cape Breton. Apparently rare in the south-western counties, and seen only near Argyle, Yarmouth County, by the Gray Herbarium Expedition to N. S. (Fernald 1921).

Nova Scotia to Minnesota south to Alabama and Oklahoma, British Columbia.

Forma *Traillae* (Lawson) Gruber. (Weatherby, C. A. Lawson's Type Specimens. Amer. Fern J. 31:2:59-62. 1941) This luxuriant form of the Marginal Fern, which has usually been given the name forma *tripinnatifidum* Clute, was found near gypsum at Antigonish Harbour, and it is abundant on wooded gypsum near Newport, Hants Co. The pinnules are deeply toothed, and are more narrowly obtuse, or acute on their ends. In the above situations it seemed distinct from the

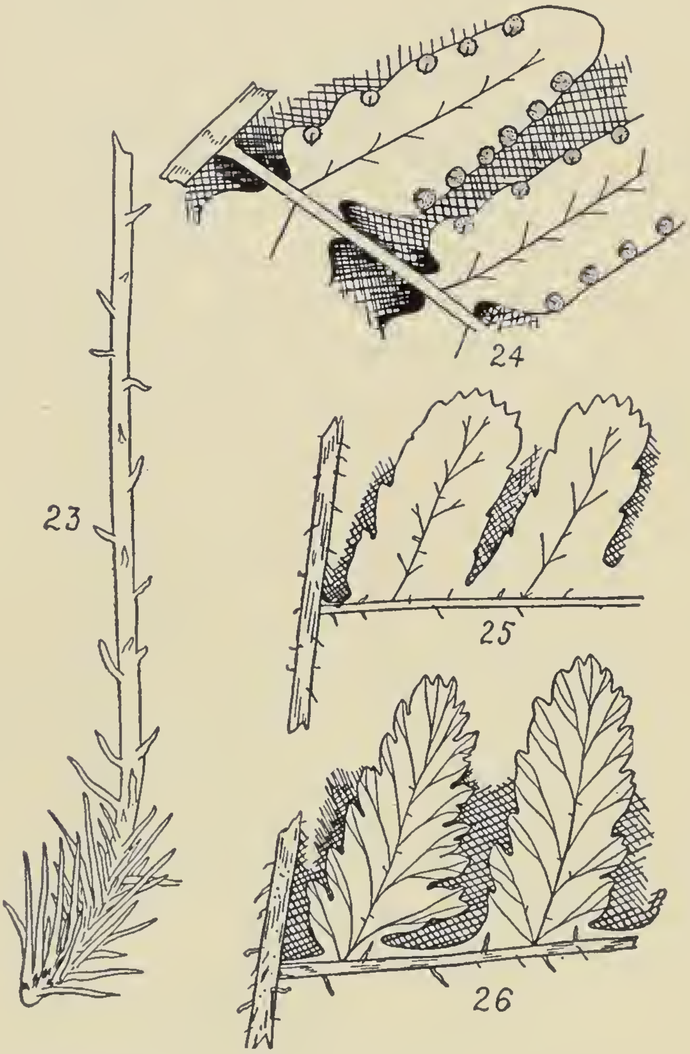


Fig. 23. Base of stipe of *D. marginalis* or *D. filix-mas*. Fig. 24. Pinnules of *Dryopteris marginalis*. Fig. 25. Pinnules of *D. filix-mas*. Fig .26. Pinnules of *D. filix-mas*, forma *incisa*.

smaller and less-toothed typical form of the species. It is a luxuriant form found throughout the range of the species.

Male Fern

8. *Dryopteris filix-mas* (L.) Schott. Figs. 23, 25. Map 5.

Named from European material; the American plant shows no essential differences.

Fronds 4-6 dm. long, 12-25 cm. wide; stipe very chaffy below with the scales brown and linear; blade firm, lanceolate, widest some distance above the base, finely chaffy beneath and on the rachis, twice-divided; pinnae tapering from the base to apex, deeply cut into oblong pinnules which are finely toothed on the sides and more prominently on the squarish tips; sori near the midrib and usually confined to the basal part of the pinnules.

The Male Fern resembles several other ferns, but the dense linear scales at the base of the stipe, and the small teeth of the pinnules without a bristle tip will distinguish it. Until now it has been found in the province only on Cape Breton Island where it is found in rich woods and ravines around Mabou, Lake Ainslie and Whycocomagh. Northward it becomes more common until around Cape North and Bay St. Lawrence it is frequently seen growing in thickets and along roadsides; and it is recorded by Nichols (1918) as here characteristic of the hardwood climax forest.

Newfoundland to Vermont and northern Michigan; British Columbia to California and Texas; Greenland, Iceland, and northern Eurasia.

Forma *incisa* (Moore) Hayek (Fig. 26) is an European form found in Newfoundland and Nova Scotia. It is characterized by the pinnules tapering somewhat to the rounded or even slightly pointed tip, and being evenly and rather coarsely toothed throughout. This seems to be a luxuriant form of the species and is common near Cape North. This fern is rather variable both in this province and in Newfoundland and Clute

(1938) states that over sixty forms have been named in Great Britain.

Crested Fern

9. *Dryopteris cristata* (L.) A. Gray.

Fertile fronds 4-8 dm. long, 8-10 cm. wide; stipe smooth with a few ovate scales near the base; blade lanceolate, firm in texture, twice-divided, widest near the apex and tapering slightly to a square base, giving it a crested appearance; pinnae lanceolate, to triangular at the base; pinnules oblong, finely toothed, with the large indusia midway between the margin and the midrib; sterile fronds differ in being ever-green, more ovate in outline, shorter, and usually less toothed.

The Crested Fern is recognized by the triangular pinnae, and by the tall erect fertile fronds. It is characteristic of well-drained swamps, swales, and boggy ground, usually in shady situations but persisting for some time in open sunlight. Common throughout the whole province.

Newfoundland to Idaho, south to Virginia; Europe.

Boott's Shield Fern

10. X *Dryopteris Boottii* (Tuckerm.) Underw.

First discovered in Massachusetts and named *Aspidium Boottii*, it was transferred to *Dryopteris* by Underwood fifty years later.

Fronds very similar to those of *D. cristata*, but wider and often larger; blade more divided, with the lower pinnae having the pinnules deeply cut or pinnatified; usually glandular; indusium glandular.

This fern is a hybrid of *D. cristata* and *D. spinulosa* var. *intermedia* and has the characters of both parents in varying proportions. Both of the parents are common throughout the province, and the hybrid, which in this case may produce viable spores to some extent, is known at present to be frequent in swampy woods of Yarmouth Co.; found at various stations in Shelburne and Lunenburg Cos.; and scattered to Halifax, Colchester, and Guysboro.

Nova Scotia to Virginia west to Minnesota.

Spinulose Shield Fern

Key to Varieties

a. The upper and lower inside pinnules of the basal pinnae nearly opposite, rarely more than 4 mm. apart, b.

b. Pinnae tending to be set obliquely to the rachis and ascending, the basal pinnae triangular, with the inner pinnule on the lower side as long or longer than the one adjacent to it; scales of the stipe light brown, c.

c. Indusium and frond smooth.

11. *D. spinulosa* (Typical).

c. Indusium and often the frond glandular.

12. var. *fructuosa*

b. Pinnae tending to be set at right angles to the rachis; the basal ones more lanceolate and tapering to a long tip, with the inner pinnules on the lower side usually much shorter than the one adjacent to it; scales of the stipe with a dark centre.

13. var. *intermedia*

a. The lower inside pinnule of the basal pinnae 5-20 mm. farther from the rachis than the inner one on the upper side, usually longer than the second upper one; blade wide and triangular; indusium glabrous, or with rarely a few marginal glands.

14. var. *americana*

11. *Dryopteris spinulosa* (O. F. Müller) Watt.

An European plant first named *Polypodium spinulosum* by Müller and transferred to *Dryopteris* in 1867.

Frond 4-7 dm. long, 10 to 20 cm. wide; blade smooth, lanceolate, twice-divided, with the pinnules further toothed or divided; pinnae widest at the base, lanceolate to triangular and set obliquely on the rachis; pinnules with bristle-tipped teeth; indusium smooth.

This fern and its varieties are the most finely divided of the genus, and may be further separated from other similar species by the bristle or spine-tipped teeth. The typical form is scattered in swamps, wet thickets and rich alluvial soil at least through the centre of the province. It generally has a thicker, less finely cut, and darker green blade than var. *intermedia.*

Newfoundland to Idaho south to Virginia and Missouri; Greenland, Europe and Asia.

12. *D. spinulosa* var. *fructuosa*(Gilbert) Trudell. (*D. intermedia* var. *fructuosa* (Gilbert) Wherry).

Similar in appearance to *D. spinulosa* but with the indusia and fronds glandular. It is thought to be a hybrid between *D. spinulosa* and var. *intermedia* and may thus possess characters intermediate between the two with considerable variability. The forms which most nearly approach *D. spinulosa* are the only ones easily identified. Often found growing with the above, Shelburne, Kings and Cumberland Counties, and probably wherever the parents occur.

13. *D. spinulosa* var. *intermedia* (Muhl.) Underw.

Many botanists separate this fern as a species, *D. intermedia* (Muhl.) A. Gray and include var. *fructuosa* under it.

The fronds are generally more finely divided, the lower pinnae are not so triangular, and the blade is lighter green in color.

This is our commonest variety and it is common throughout the whole province in woods, on rocky slopes, and hummocks in swamps.

Newfoundland to Wisconsin south to North Carolina and Missouri.

14. *D. spinulosa* var. *americana* (Fisch.) Fernald.

This is the American variety parallel to var. *dilatata* of Europe with which it was first connected. (*Aspidium spinulosum* var. *dilatatum* f. *anadenium* Robinson of Gray's Manual). It is sometimes set off as a separate species, *D. campyloptera* (Kunze) Clarkson. This name was suggested as a substitute name by Kunze when he published Fischer's description of the variety.

Similar to the above varieties but with the blade larger and more triangular. It is a more northern variety and is typical only of our colder and richer woods. It is luxuriant in rich woods along the Bay of Fundy and around Minas Basin, with fronds six to twelve dm. high; scattered in rich woods and slopes from Shelburne to Cape Breton; and common along the Cobequids and in northern Cape Breton. Miss Perry (1931) states that both this and var. *intermedia* are common on St. Paul Is. (northern Cape Breton); and about as abundant as the two varieties was a form transitional between the two.

Labrador to British Columbia south to Wisconsin and along the mountains to North Carolina and Tennessee.

ONOCLEA L.

Rootstock slender and creeping; fronds of two kinds, the sterile herbaceous with the pinnae more or less lobed, and the veins forming a network; the fertile indurated, with the sori borne inside the berry-like rolled pinnules.

Sensitive Fern

O. sensibilis L. Fig. 2.

Sterile fronds 3-8 dm. long, 15-30 cm. wide, with the blade nearly triangular and the rachis broadly winged; fertile fronds shorter, the fertile part 1 to 2 dm. long, with the branches rigidly erect, persisting over the winter.

Easily identified by the coarse blades and netted-veined pinnae. The fertile fronds may be seen in most wet places and low areas after the other vegetation has been withered by the frost.

Common throughout in wet mucky soil, around streams, pools, ditches, in woodland or in open fields.

Newfoundland to Saskatchewan south to Florida and Texas.

O. sensibilis f. *obtusilobata* (Schkuhr) Gilbert.

This form is produced when the early sterile fronds are injured in some way. It is intermediate between the normal sterile and fertile fronds, and often appears like a much stunted deeply-lobed form. Commonly seen in the Annapolis Valley along roadsides or at the edge of fields where the early fronds were mown.

PTERETIS Raf.

Rootstock stout and ascending; fronds of two kinds, the sterile large and green, arranged in a circle and the fertile indurated with the pinnae and pinnules rolled, and the sori borne inside the tube-like pinnae.

Ostrich Fern

P. nodulosa (Michx.) Nieuwl. Fig. 3. Map 6.

Botanists have long debated whether to put *Pteretis* and *Onoclea* in the same genus. This fern has had the following names successively applied to it: *Osmunda Struthiopteris*, *Onoclea Struthiopteris*, *Struthiopteris Germanica*, *Struthiopteris pennsylvanica*, *Matteuccia Struthiopteris*, and *Matteuccia nodulosa*. Our American plant was named *Onoclea nodulosa* by Michaux and finally given *Pteretis nodulosa* by Nieuwland in 1916.

Sterile frond 6-12 dm. long, 15-25 cm. wide, blade widest above the middle, with the pinnae abruptly shortened at the tip and gradually tapering to the base, rachis smooth on the sides and back and slightly pubescent on the groove in front; fertile frond up to 30 cm. long and 5 cm. wide, persisting over winter.

This fern is very similar in general appearance to the Cinnamon Fern, but differs in the blunt top of the frond, the tapering base, the unforked veins, and the absence of rusty wool.

Found in rich, deep soil, low ground and along streams; common in the Annapolis Valley and Colchester and Pictou Counties; about limestone and gypsum outcrops in Cape Breton; and reported by Nichols (1918) as characteristic of the higher parts of the flood plains in northern Cape Breton.

Not mentioned by Fernald from southwestern N. S. and it is presumably absent from the more acid regions of the province.

Newfoundland to Alaska, south to Virginia and Missouri.

CYSTOPTERIS Bernh.

Fronds thin, lanceolate, and twice-divided, from short rootstocks; veins forked; sori roundish; indusium thin and evanescent, attached at the base of the sorus and arching over the sporangia.

Key to Species and Varieties

a. Frond lanceolate, and usually long-attenuate, often bearing bulblets beneath, veins of the pinnules ending mostly in a notch, Fig. 27.

1. *C. bulbifera*

a. Frond lanceolate only; veins of the pinnules ending mostly in a tooth or on the un-notched margin, Fig. 28, b.

b. Pinnules, at least the basal, varying from nearly orbicular to triangular, rounded to the base; indusium up to 1 mm. long, and more or less cleft at the apex, c.

c. Indusium without glands; fronds small, up to 3 dm. long.

2. *C. fragilis* (Typical).

c. Indusium glandular on the back; fronds large, 3.8-4.8 dm. long.

3. var. *laurentianum.*

b. Pinnules of the frond oblong to nearly lanceolate, evenly wedge-shaped at the base; indusium short, about 0.5 mm. long and shallowly or not at all toothed at the apex.

4. var. *Mackayii*

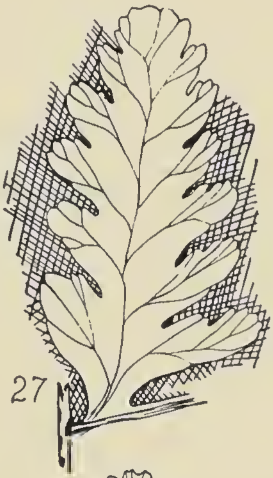
Bulblet Fern

1. *C. bulbifera* (L.) Bernh. Fig. 27. Map 7.

Plants sent from Canada were named *Polypodium bulbiferum* by Linnaeus and they were included by Bernhardi in his new genus *Cystopteris* in 1806.

Fronds 2-6 dm. long, 6-10 cm. wide; stipe smooth; blade lanceolate, widest at the base and tapering to a long attenuate tip, twice-divided; pinnae widest at the base; pinnules oblong, rounded at the end and bluntly double-toothed; sori small and round, situated on a vein, and with a short, blunt indusium.

The Bulblet Fern is recognized by its thin, long tapering fronds and by tiny bulblets on the lower side of the mature plants. Smaller plants may be distinguished by the toothing and the veining of the pinnules. This fern is only found in the province in rich or calcareous areas. Kings County: Moore's Falls, south of Kentville; Hants County: common on gypsum outcrops near Brooklyn, St. Croix, and along Five Mile River; Guysboro County: shaded cliffs at Hartley's Waterfall on the Strait of Canso; and common and often luxuriant in rich shady ravines near limestone in Cape Breton.


27

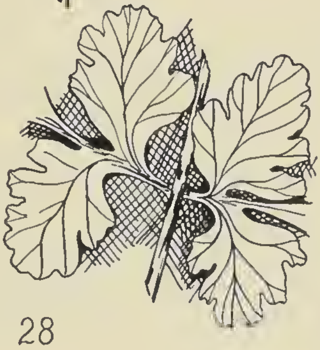

28

Fig. 27. Pinnule of *Cystopteris bulbifera.* Fig. 28. Basal pinnules of *Cystopteris fragilis* (typical).

Plants growing on dryish gypsum cliffs in Hants County fruit abundantly and bear bulblets without producing the long attenuate tips. These short blunt fronds with more horizontal pinnae seem to approach the shape of forma *horizontalis* (Lawson) Clute, a form which may only be a response to the dryish and unfavourable environment.

Newfoundland to Manitoba south to Georgia and Arizona.

Fragile Fern

2. *C. fragilis* (L.) Bernh. Fig. 28. Map 8.

Weatherby, C. A. A new North American Variety of *Cystopteris fragilis.* Rhodora 28: 129-131. 1926.

Weatherby, C. A., A New Variety of *Cystopteris fragilis* and some old ones. Rhodora. 37:373-378. 1935.

Frond 1-3 dm. long, 3-6 cm. wide; stipe smooth; blade lanceolate, slightly broader above the base; twice-divided; pinnae nearly triangular; largest pinnules near the rachis oblong to triangular and rounded at the base; sori small and separate, covered by an oblong indusium which is more or less deeply lobed at the tip.

The Fragile Fern is rather common on shaded and rocky cliffs, and in rich moist woods throughout the northern part of the province; Nichols (1918) lists it as characteristic of shady cliff crevices in northern C. B. Nova Scotia is the region where the range of the northern *C. fragilis* overlaps that of the more southern var. *Mackayii.* Intermediate forms thus occur, so that it is often difficult to name the collections correctly. The typical form occurs at least in Cape Breton and along the Bay of Fundy at Blomidon and Baxter's Harbour while most of the inland and woodland specimens apparently belong to the variety.

Newfoundland to Alaska south to northern New England, Pennsylvania, Missouri, Texas and southern California.

Forma *cristata* (Lowe) Weatherby. The Fragile Fern is rather variable in its outline and various forms have been described by European botanists which probably also apply correctly to the American forms. This one seems the best marked, and Macoun and Burgess (p. 213, 1884) state—"A very peculiar form found at Whycocomagh, N. S. . . . has the ends of the fronds as well as most of the pinnae and some of the pinnules forked or showing a tendency thereto."

3. Var. *laurentiana* Weatherby.

This variety is a larger, more erect and coarser plant, the fronds being 3.8-4.8 dm. high, with their blades 19-34 cm. wide; indusium, and frequently the rachis of the pinnae beneath, minutely glandular.

It is at once distinguished by its glandular indusia. Var. *laurentiana* is one of a number of relic plants found in Newfoundland, Gaspe, the Magdalens, in northern Cape Breton and sparingly westward on the Bruce Peninsula, Ontario, and Wisconsin. It almost always grown in calcareous locations and the two following collections made by Nichols were mentioned by Weatherby (1926): dolomite ledges west of Dingwall; moist sink holes in plaster, South Ingonish.

4. Var. *Mackayii* Lawson. Fig. 17. Map 8.

Pinnules tapering or wedge-shaped at the base, rounded at the tip and only slightly toothed, or narrower and more deeply toothed; indusium blunt and up to 0.5 mm. long. Shaded ledges, damp cliffs, and occasionally in rich woods, Digby Neck and northern Queens Co. to Cape Breton; frequent but never abundant in its habitat.

Nova Scotia and southern Quebec to Minnesota south to North Carolina.

WOODSIA R. Br.

Rootstock small; veins forked; sori small and round; indusium composed of several jagged lobes or thread-like divisions, attached beneath the sporangia and curving over them.

Key to the Species

a. Stipe plainly jointed near the base; lobes of the indusia linear and hair-like; frond chaffy or smooth but not glandular, b.

b. Frond chaffy throughout; blade oblong-lanceolate.

1. *W. ilvensis*

b. Frond smooth; blade linear and delicate.
2. *W. glabella*

a. Stipe not jointed; lobes of the indusium of a few broad segments; frond often glandular.
3. *W. obtusa*

Rusty Woodsia

1. *W. ilvensis* (L.) R. Br. Fig. 16. Map 9.

Linnaeus named an European fern *Acrostichum ilvense* in 1753 and Robert Brown placed it in his new genus *Woodsia* in 1810. The American plant appears to be the same.

Frond 5-15 cm. long; stipe reddish, sparingly chaffy, jointed near the base; blade widely lanceolate, widest above the base, more or less chaffy, twice-divided; pinnae ovate-triangular, blunt, deeply divided into rounded pinnules; sori numerous, nearly covering the lower surface of the pinnules; indusia difficult to distinguish from the chaff of the blade, of many thread-like divisions.

The Rusty Woodsia is best distinguished by its small chaffy blade, and jointed stipes. It is local, but often abundant where found; on basaltic cliffs, slaty ledges, talus slopes, and rocky ravines from Digby Neck to Truro; and reported by Nichols (1918) as characteristic of cliff associations in northern Cape Breton. Labrador to Alaska southward to British Columbia, Iowa and North Carolina.

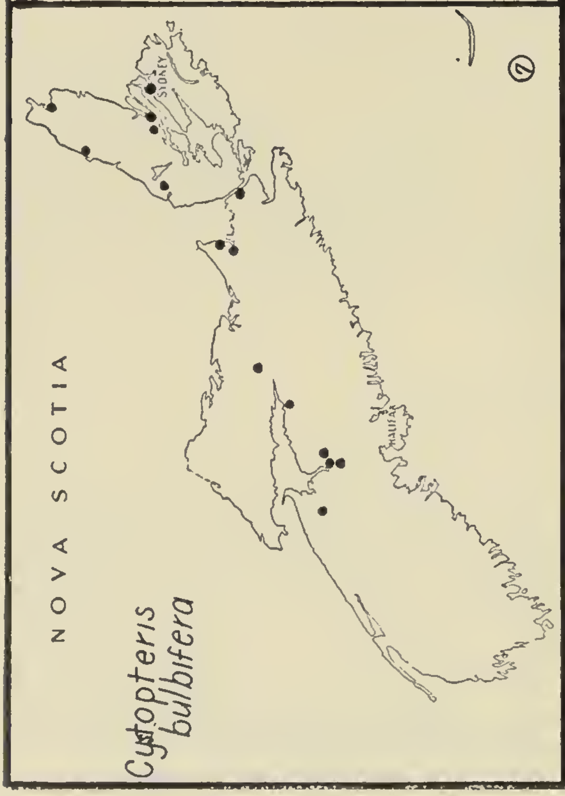
Smooth Woodsia

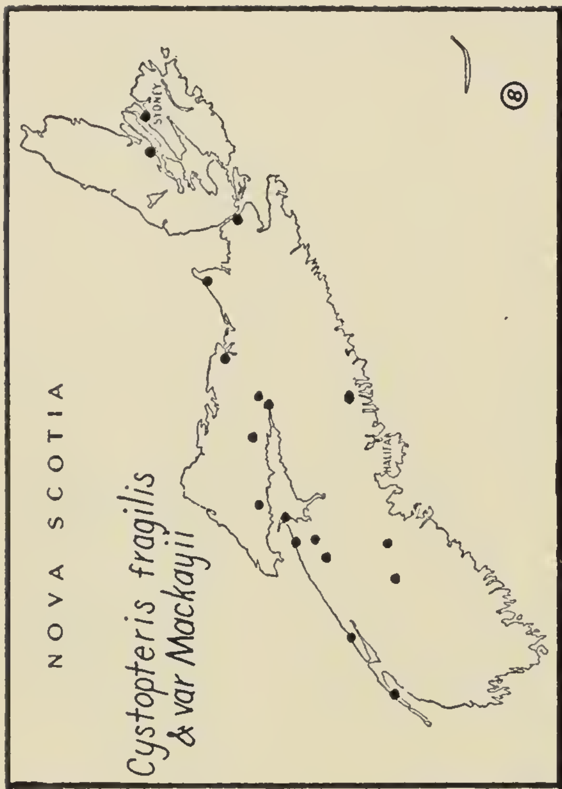
2. *W. glabella* R. Br.

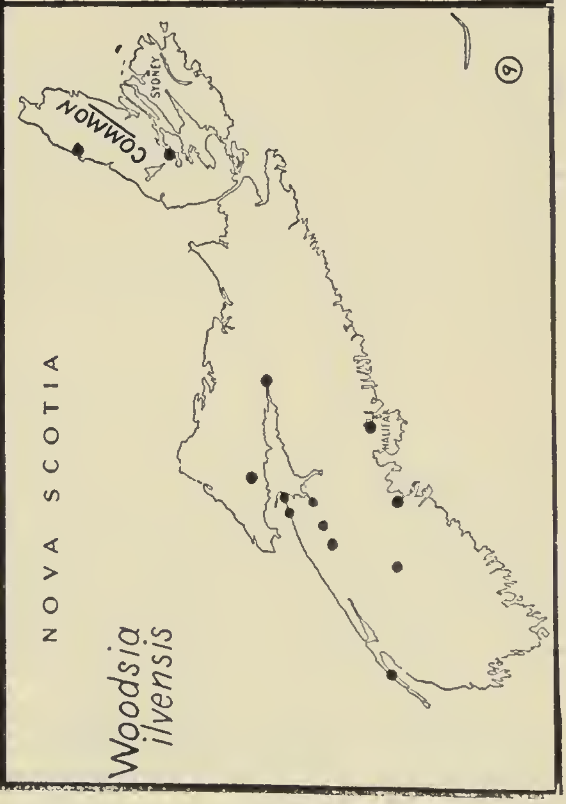
Frond rather similar to that of *W. ilvensis* but entirely smooth; 4-16 cm. long; blade delicate and linear; pinnae 3-9 mm. long, roundish-ovate, rather obtuse.

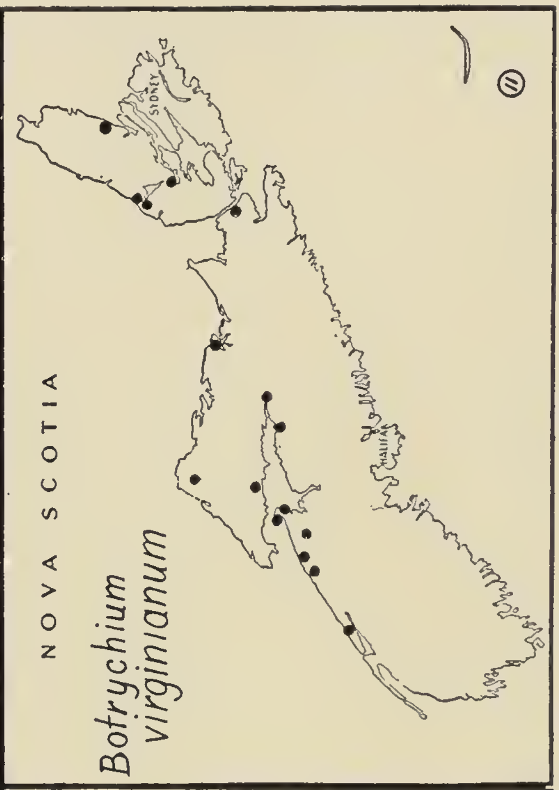
The Smooth Woodsia has been recorded but once for the province. (Robinson 1904). Two plants were found near the summit of a hill, 1300 feet high, near Cheticamp.

Newfoundland to Alaska south to North Carolina and New York; Europe and Asia.


NOVA SCOTIA
Cystopteris bulbifera
SYDNEY
HALIFAX
7


NOVA SCOTIA
Cystopteris fragilis & var Mackayii
SYDNEY
HALIFAX
8


NOVA SCOTIA
Woodsia ilvensis
COMMON
SYDNEY
HALIFAX
9


NOVA SCOTIA
Botrychium virginianum
SYDNEY
HALIFAX
11

Blunt-Lobed Woodsia

3. *W. obtusa* (Spreng.) Torr.

Frond 2-3 dm. long, 3-10 cm. wide; stipe with scattered small scales; blade lanceolate, glandular, twice-divided with oblong rounded pinnules; indusium of several spreading jagged lobes.

This fern resembles *Cystopteris fragilis* closely in appearance and habitat, but may be distinguished by the scales or chaff on the stipe, and by the glandular blades.

Lindsay's Catalogue (1876) lists it from Windsor Falls, but the specimens on which this record is based are depauperate plants of *Dryopteris marginalis*. Macoun (1883-1890) records it "In the gorge through which Dr. Hamilton's road winds up to the summit of the North Mountain near Canning". This is now called the Deep Hollow Road north of Sheffield Mills. The second record seems to be the basis for the inclusion of Nova Scotia in the range of this fern in all recent manuals, as no recent collections are known.

Nova Scotia to Minnesota, south to Florida and Texas; British Columbia to Alaska.

SCHIZAEACEAE Curly Grass Family

SCHIZAEA J. Sm.

Small ferns with linear sterile fronds, and fertile ones with a very small blade; sporangia borne in double rows along the pinnae, with a transverse ring at the apex, and opening vertically by a longitudinal slit.

Curly-Grass Fern

S. pusilla Pursh. Fig. 1. Map 10.

Discovered in New Jersey and named by Pursh in 1814.

Sterile fronds linear and variously coiled, 1-3 cm. long; fertile fronds 3-7 cm. high, smooth; blade 2-5 mm. long, consisting of 2-5 pairs of pinnae folded together along the rachis, protecting the sporangia within.

The Curly-grass Fern is so different that it could not be mistaken for any other fern; it is so rare and insignificant that few people in the province have ever seen it growing. It was first found on the shores of Grand Lake, Halifax County, by Miss Elizabeth Knight (later Mrs. Brittain) of New York in 1879, and she was never able to find it at that place again. (Lawson, p. 249, 1889). In 1905 Nichols found it in northern Cape Breton; and later (Nichols 1918) reported it as characteristic of swamps in the highlands. In 1921-22 Professor Fernald and other members of the Gray Herbarium Expedition to Nova Scotia found it at various places from Digby Neck around to Queens County and also rediscovered it around the shores of Grand Lake.

This fern seems to be most abundant in bogs at the southern ends of Long and Brier Islands, Digby County, usually growing within a few yards of the sea. Specific locations for the plant will be found in Rhodora. 23:186. 1921 and Rhodora. 24:159. 1922. It is usually found in spagnous bogs, peaty borders of lakes, sphagnous hollows in barrens, and in wet grassy depressions.

Newfoundland, Nova Scotia and southern New Jersey; also the Bruce Peninsula, Ontario.

OSMUNDACEAE Flowering Fern Family

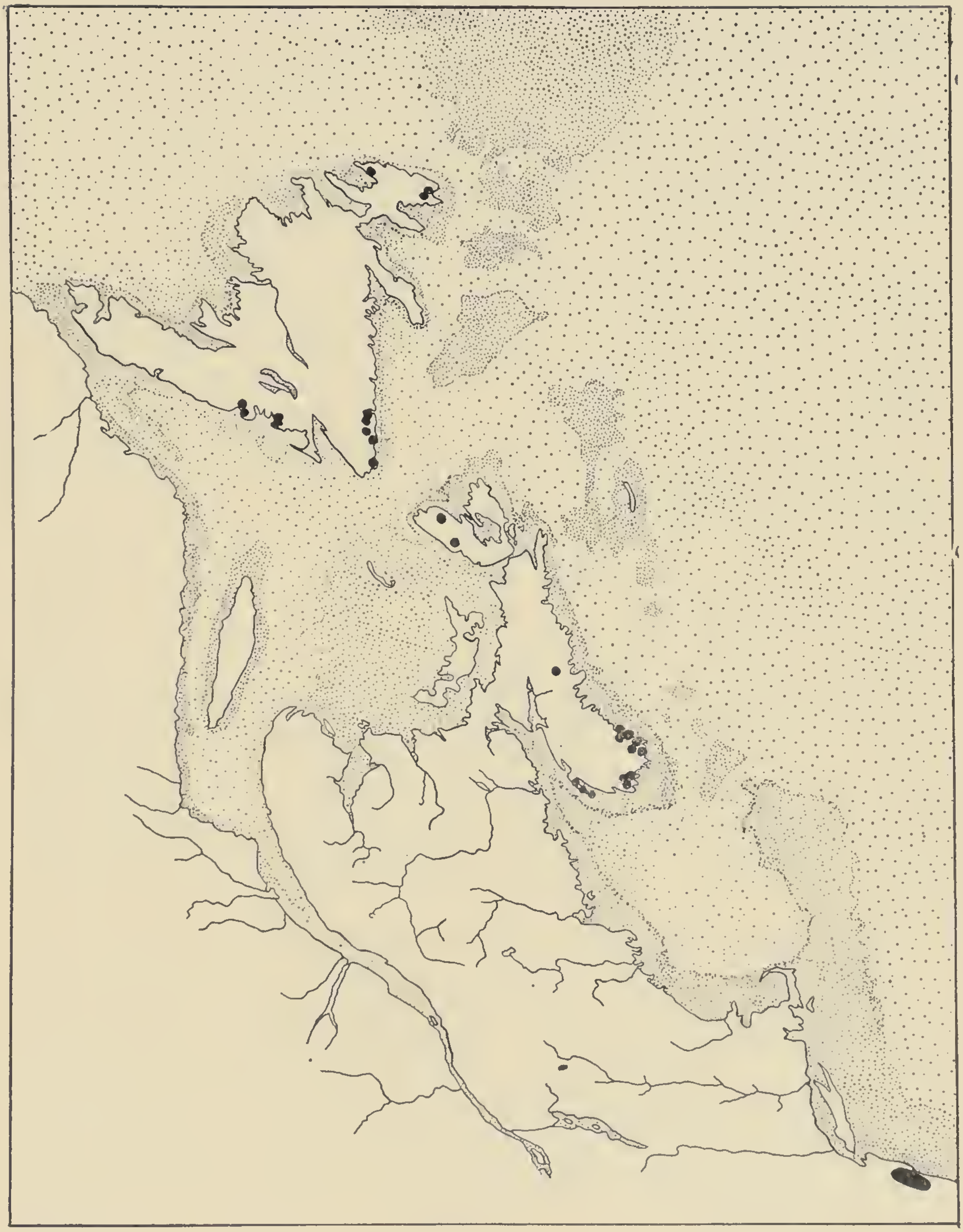
OSMUNDA (Tourn.) L.

Large plants with stout creeping rootstocks; fronds growing in clumps, with the veins of the pinnules forked; sporangia borne on completely fertile fronds or parts of the frond. Our forms consist of the following three species which are keyed out in the main key, pg. 69-70.

Royal Fern

O. regalis L. var. *spectabilis* (Willd.) A. Gray. Fig. 5.

Linnaeus included both the European and the American forms under *O. regalis.* In 1810 Willdenow separated off the



Map 10. Range of *Schizaea pusilla*. Data from a map published by Fernald in Rhodora. 35: 86. 1933.

American forms as *O. spectabilis* and Gray in 1856 reduced this to varietal rank.

Frond smooth, 5-15 dm. high, 12-25 cm. wide; blade twice-divided with oblong-oval to lance-oblong finely toothed pinnules; fertile portion at the apex of the fronds with the pinnules appearing like fine linear masses of sporangia.

The Royal Fern deserves its name because of the tall, stately fronds. It is recognized by its large pinnules and terminal fertile portion. Common in wet places, usually along streams next to running water, but often also on the shores of lakes, in marshes and wet woods. Common throughout the province.

Newfoundland to Saskatchewan south to Florida, Texas and into South America.

Cinnamon Fern

O. cinnamomea L. Fig. 4.

Named by Linnaeus from American material.

Sterile fronds 4-12 dm. high, 12-20 cm. wide, blade twice-divided, with the rachis bearing a tuft of wool at the base of each pinnae; pinnules smooth edged and slightly pointed; fertile fronds 3-6 dm. high and 2-3 cm. wide, very brown and woolly, consisting of masses of sporangia on the modified pinnae.

The Cinnamon Fern is one of our commonest ferns. The unrolling crosiers in early spring are known as fiddle-heads; and later the circular crown of green fronds with the numerous spike-like rusty fertile ones in the centre are very conspicuous. Common in swamps, bogs, wet pastures, low fields, and roadsides everywhere; often a weed in poorly-drained areas, with stout rootstocks and extremely difficult to plow through when land is broken up.

Newfoundland to Minnesota south to Florida and New Mexico.

O. cinnamomea f. *frondosa* (Torr. and A. Gray) Britton.

This form has fronds intermediate between the fertile and the sterile ones. Often the pinnae may be crisped and toothed with some sporangia; or the lower part of the frond may be sterile and the top fertile. Not uncommon. Lindsay (1876) reported it from Windsor and specimens were seen from Halifax and Colchester Counties. Range of the species.

A form was collected west of Kentville with the pinnules tapering to a longer acute tip instead of a rounded one, and with traces of rusty wooly around their margins.

Interrupted Fern

O. Claytoniana L.

Clayton collected this fern in Virginia, and Linnaeus named it in his honor.

Fronds 6-12 dm. high, 12-25 cm. wide; blade twice-pinnate, the lower surface with rusty hairs at first but later smooth and green; fertile portion consisting of 1-5 pairs of smaller modified pinnae in the middle of the frond, which soon disappear and leave an open space; sterile pinnae as in Fig. 4; fronds easily distinguished from the fronds of *O. cinnamomea* by the absence of the tufts of brownish wool at the base of the pinnules, and by the gaps in the fronds.

Scattered but not nearly so common as the last, generally in moist thickets, margins of swamps, usually not often in open sunlight. Throughout the province.

Newfoundland to Manitoba south to Georgia.

OPHIOGLOSSACEAE Adder's Tongue Family

OPHIOGLOSSUM (Tourn.) L.

Rootstock fleshy with slender fleshy roots; frond with an ovate sterile blade; the sporangia in two ranks on the edges of a simple spike, opening by a longitudinal slit.

Adder's Tongue

O. vulgatum L. var. *pseudopodum* (Blake) Farwell. Fig. 6.

Named from European material by Linnaeus in 1753. Smaller variations of the plant in North America were once erroneously referred to the European variety *minus* Moore, and in more acid soils a form occurs with more narrowed leaves which has been named *O. arenarium* E. G. Britton. Fernald (p. 187, 1921) states that in the sterile meadows of Digby and Yarmouth Counties plants varying from the large forms to the smallest extremes can be found in different portions of the same colony.

The American plants have recently been divided into three varieties with our Nova Scotian plants referred to the above. (Fernald, M. L. Rhodora. 41:494-499. 1939).

Frond 5-25 cm. high; stipe succulent, hollow; bearing a sessile leaf-like blade, 3-8 cm. long, 1-4 cm. wide; fertile part appearing like a continuation of the stipe with a spike at the top 2-4 cm. long.

The Adder's Tongue is quite different from any other fern and is recognized by its ovate blade and unbranched spike. It is frequent in Yarmouth and Digby Counties where it is found on damp sandy and cobbly beaches of lakes or in sterile meadows and has been collected near Halifax, Truro and Amherst. It is difficult to distinguish from the surroundings, and is probably often overlooked.

Nova Scotia and Prince Edward Island to Washington south to Mexico, Indiana and Delaware.

Botrychium Sw.

Rootstock short with clustered, fleshy roots; fronds composed of a fertile and a sterile portion; the sterile blade ternately or pinnately divided; the fertile part more or less branched with the divisions bearing a double row of sessile naked sporangia; sporangia large, and splitting into two valves at maturity.

Key to Species

a. Sterile blade small, oblong to triangular, attached near the middle or top of the plant, b.

  b. Sterile blade oblong or ovate, with a short stalk, c.

c. Sterile blade once-divided, with three or more pairs of fan or spoon-shaped pinnae.

1. *B. Lunaria*

c. Sterile blade variously cut, with pinnae of different shapes; if the pinnae fan- or spoon-shaped the plants very small with not more than two pairs of pinnae present, d.

d. Sterile blade simple with the sides at the base curving inward, or once-divided with fan-shaped pinnae, or twice-divided with the pinnules smooth-margined.

2. *B. simplex*

d. Sterile blade usually larger and more divided; if undivided with the sides at the base curving outward, if once-divided with the pinnae ovate, and if twice-divided with the pinnules toothed.

3. *B. matricariaefolium*

b. Sterile blade triangular; sessile with acute lobes.

4. *lanceolatum* var. *angustisegmentum*

a. Sterile blades large, triangular, finely divided, e.

e. Sterile blade stalked, joined to the fertile portion near the base of the plant, f.

f. Chief terminal divisions usually elongate, more than twice as long as broad; often deeply dissected, g.

g. Segments finely and deeply dissected.

5. *B. dissectum*

g. Segments with a smooth margin or lobed at the base, finely serrate.

6. *B. dissectum* forma *obliquum*

f. Chief terminal divisions mostly ovate to oblong, not elongate.

7. *B. multifidum.*

e. Sterile blade not stalked, thin, and finely divided, attached near the middle or upper part of the plant.

8. *B. virginianum.*

Moonwort

1. *B. Lunaria* (L.) Sw.

Described by Linnaeus and placed in the genus *Botrychium* by Schwartz in 1801. The following variety was described as a species by Victorin from Gaspe material in 1927 and was later reduced to varietal rank by Dole.

The species is rather fleshy, 8-18 cm. high; sterile blade oblong, borne in the middle of the plant, once-divided with 2-8 pairs of fan-shaped smooth-edged segments; fertile portion shortly branched; spores 25-35 mm. in diameter.

Var. *minganense* (Victorin) Dole differs by having the blade lighter-green in color, by its habits of growing in clumps, and by the more spoon-shaped pinnae with usually incised edges; spores 30-40 micron in diameter.

Typical *B. Lunaria* is a plant of worldwide distribution which in America is boreal in its range and usually occurs on limestone or other calcareous rocks. It has not yet been found in Nova Scotia, but it occurs from Newfoundland to Alaska south to Maine, northern Michigan, and along the Rocky Mountains. The variety *minganense* is reported from New Campbellton, C. B. (Clausen 1938).

Small Grape Fern

2. *B. simplex* Hitchc.

A circumboreal species first named by Hitchcock on material from Massachusetts.

Fronds small, 4-15 cm. or rarely higher; sterile blade long-stalked, inserted usually toward the middle or base of the plant, varying from an ovate simple outline to a larger more-divided one, with crowded irregular pinnae; spores 35-50 micron in diameter.

The Small Grape Fern is distinguished mainly by its small size and smooth-edged divisions of the blade. In appearance the plants are sometimes similar to forms of *B. matricariaefolium* and then the larger size of the spores alone will separate them. Clausen (1938) reports it as common in Maine, and from Cumberland, Lunenburg and Yarmouth Counties in Nova Scotia, with no mention of New Brunswick or Prince Edward Island. The Cumberland record is probably the same as Lawson's (1889) and Macoun's (1883-1890) record for Truemanville; and that for Yarmouth County based on Fernald's

(p. 187, 1921) collection: "Rare: a small colony of extremely dwarf plants, sandy and gravelly beach of Cedar Lake".

Newfoundland to New Jersey and Pennsylvania west to British Columbia and California. Europe and Asia.

Matricary Grape Fern

3. *B. matricariaefolium* A. Br.

The name of the European plant was first suggested by A. Braun, and published in 1843. The American plant has often been considered a separate species and named *B. neglectum* Wood. The differences between the plants are at present considered insignificant. It has also been known as *B. ramosum* (Roth) Aschers.

Fronds 1-2.5 dm. high; the sterile blade oblong to ovate, varying from merely lobed to twice-divided, 1-4 cm. long, short-stalked, the lobes oblong-ovate and with rounded teeth; spores 25-35 mm. in diameter.

The Matricary Grape Fern is separated from the Small Grape Fern by its more lobed blades and smaller spores. It is very similar in size and appearance to the next, but is separated from it by the blade being slightly stalked and by having its lobes rounded instead of pointed. It is usually found in rich humus soil in hardwoods. Clausen (1938) reports it from Annapolis, Cumberland, Kings and Inverness Counties; and these records refer to the following: "Rare, a solitary plant in mixed woods, southern slope of the North Mountain, Middleton", Fernald (1921); "Pictou, Truemanville, Blomidon", Lawson (1889); "Other species commonly encountered on bleak exposed headlands are *Botrychium ramosum* etc.," Nichols (1918).

Newfoundland to Alberta south to Maryland and Ohio; northern Eurasia.

Lance-Leaved Grape Fern

4. *B. lanceolatum* (S. G. Gmel.) Angstrom. var. *angustisegmentum*, Pease and Moore.

Discovered in Russia and named *Osmunda lanceolata* by Gmelin and later transferred to *Botrychium.* This is essentially an European and boreal plant. In 1906 Pease and Moore pointed out the differences of the southern variety, which is sometimes regarded as a separate species, *B. angustisegmentum* (Pease and Moore) Fernald.

Plant 1-3 dm. high; sterile blade near the top of the plant, 2-5 cm. long, broadly traingular, not stalked, once-divided, the pinnae with narrow sharp teeth; fertile part with spreading branches; spores 25-35 micron in diameter.

The Lance-leaved Grape Fern is distinguished by its unstalked triangular blade with the sharp-pointed lobes. It is apparently rare in the province. Lawson (1889) reported it from Truemanville; Clausen (1938) from Cumberland and Inverness Counties; and there is a specimen in the herbarium at the Agricultural College from a rich wooded hillside, Moose River, Cumberland County.

Usually growing in rich hardwood soil, Newfoundland to Wisconsin south to Pennsylvania and West Virginia.

Cut-Leaved Grape Fern

5. *B. dissectum* Spreng.

This fern was discovered in Virginia and sent to Sprengel who named it in 1804. The following variety, long considered a separate species, was named *B. obliquum* in 1810. Fernald, (p. 151, 1921), states that along "the railroad southeast beyond Yarmouth . . . *Botrychium dissectum* and var. *obliquum* were very abundant and here, as elsewhere in Nova Scotia and the eastern states, show such a connecting series as clearly to indicate that they are mere forms of the same plant, and since *B. dissectum* Spreng. has a priority of six years over *B. obliquum* Muhl. it is necessary to call the latter *B. dissectum*, forma *obliquum.*"

Plants rather slender, 1-3 dm. high; sterile blade long-stalked, joined to the fertile part near its base and about two-thirds its height, triangular, twice to three times divided, with the long segments deeply cut into numerous linear lobes.

The finely-dissected blade of this fern separate it from the other grape ferns. Frequent or common in sandy or gravelly, either open or turfy soils of Digby, Yarmouth and Shelburne Counties; older records are from Mount Uniacke, New Germany and Halifax.

Nova Scotia to Minnesota south to Florida and Missouri.

6. Forma *obliquum* (Muhl.) Fernald.

Similar to *B. dissectum* and of very similar range, but with the segments smooth or lobed at the base and merely finely toothed; terminal divisions oblong-lanceolate, much narrower than in *B. multifidum.*

Frequent to common in the southwestern counties, growing with the typical form. It becomes much rarer eastward to Kingston, Kings County; Halfway River, Cumberland County; and Folleigh Lake, Colchester County.

Leathery Grape Fern

7. *B. multifidum* (S. G. Gmel.) Rupr. Fig. 7.

Gmelin named a Russian plant *Osmunda multifida,* and Ruprecht in 1859 placed it in the genus *Botrychium.* In Gray's Manual this plant is mistakenly associated with *B. ternatum* (Thunb.) Sw. of Europe as var. *rutaefolium* (A. Br.) D. C. Eaton; and in Britton and Brown the name *B. matricariae* (Schrank) Speng. is used.

Frond 1.5-3 dm. high; sterile blade long-stalked, connected near the base of the plant, leathery in texture, triangular, 4-14 cm. wide, twice to three times divided with the divisions crowded and ovate to oblong, sometimes lobed or bluntly toothed; fertile portion stout, twice the height of the sterile portion, and much branched.

The Leathery Grape Fern is very variable in size and texture in the province, and large luxurient forms approach var. *intermedium* (D. C. Eaton) Farwell. (*B. silaefolium* Presl.). However, since the blade is rather thick with crowded segments, I am treating them all as variations of typical *B multifidum.* This fern is found in moist woods, grassy pastures and sandy hillsides from Digby County to Cape Breton, and is apparently rare or absent from the southwestern counties. Clausen (1938) reports it from Inverness, Colchester, Cumberland, Kings and Digby Counties. In Kings and Colchester it is frequently seen in pastures and hillsides and it is probably the commonest member of the family throughout most of the province.

Newfoundland to Alberta south to New York; northern Europe and Asia.

Rattlesnake Fern

8. *B. virginianum* (L.) Sw. Map 11.

Although this species occurs in Europe and Asia, Linnaeus first described and named plants from Virginia. The species was placed in Botrychium in 1801.

Four varieties were described by Butters, and the Nova Scotian specimens listed were placed in var. *intermedium* Butters. However, since most students of the *Botrychia* have difficulty in separating these forms, they merge var. *intermedium* with the typical form and unite var. *laurentianum* with the fourth as var. *europaeum* Angstrom. Butters F.K. *Botrychium virginianum* and its American Varieties. Rhodora. 19:207-216. 1917.

Plant usually growing singly, 4-6 dm. high; sterile blade triangular, of three main divisions, sessile, attached half-way up the plant and almost horizontal, 15-30 cm. wide, and finely divided; fertile portion slender with numerous slender erect branches.

This fern is the most graceful and distinctive of the genus. It is frequent, but never abundant in rich shady woods from Annapolis to northern Cape Breton. Nova Scotia to British Columbia south to Florida and California.

Var. *europaeum* Angstrom has a less dissected, comparatively thick and firm-textured sterile blade and generally larger sporangia. This seems to be more of a northern form of the plant known from Labrador and Newfoundland south to northern New Brunswick, northern Maine and westward; also in northern Europe.

ACKNOWLEDGEMENT

I wish to thank Mr. C. A. Weatherby, of Gray Herbarium, for the generous assistance he has given me in identifying the more difficult forms and varieties, for the information he has given me about the different ferns, and for reading over the manuscript for this paper.

BIBLIOGRAPHY

Ball, E. H. *The Indigenous Ferns of Nova Scotia.* Proc. N. S. Inst. Nat. Sci. **4**: (2): 146-157. 1876.

Broun, Maurice. *Index to North American Ferns.* Published by the author, route 1, Orwigsburg, Penn., 1938.

Clausen, R. T. *A Monograph of the Ophioglossaceae.* Memoirs of the Torrey Botanical Club. **19**: No. 2. The New York Botanical Garden, Bronx Park, Fordham Branch P. O., New York. 1938.

Clute, W. N. *Our Ferns, Their Haunts, Habits and Folklore.* 2nd. Ed. Frederick Stokes Co., New York. 1938.

Fernald, M. L. *The Gray Herbarium Expedition to Nova Scotia.* Rhodora **23**: 89-111; 130-152; 153-171; 184-195; 223-245; 257-278; 284-301. 1921.

Fernald, M. L. *Notes on the Flora of Western Nova Scotia*, 1921. Rhodora. **24**: 157-164; 165-180; 201-208. 1922.

Lawson, George. *The School Fern-flora of Canada.* 1889.

Lindsay, A. W. H. *A Catalogue of the Flora of Nova Scotia.* Proc. N. S. Inst. Nat. Sci. **4**: (2): 184-222. 1876.

MacKay, A. H. *Botanical Notes in Nova Scotia.* Proc. N. S. Inst. Sci. **11**: (2): 286-288. 1906.

Macoun, John. *Catalogue of Canadian Plants.* Montreal. 1883-1890.

Macoun, John and Burgess, T. J. W. *Canadian Filicineae* Trans. Roy. Soc. Canada. **2**: Sect. 4: 163-226. 1884.

Nichols, G. E. *The Vegetation of Northern Cape Breton Island. Nova Scotia.* Trans. Conn. Acad. Arts. and Sci. **22**: 249-467. 1918.

Perry, L. M. *Vascular Flora of St. Paul Island, Nova Scotia.* Rhodora. 33: 105-126. 1931.

Robinson, B. L. and Fernald, M. L. *Gray's New Manual of Botany.* 7th. Ed. American Book Co., New York. 1908.

Robinson, C. B. *The Ferns of Northern Cape Breton.* Torreya. 4: 136-138. 1904.

Tryon, R. M. Jr., Fassett, N. C., Dunlop, D. W., Diemer, M. E. *The Ferns and Ferns Allies of Wisconsin.* Botany Dept. University of Wisconsin, Madison, Wisc. 1940.

Weatherby, C. A. *A List of Varieties and Forms of the Ferns of Eastern North America.* Amer. Fern J. **25**: 45-51; 95-100. 1935. **26**: 11-16; 60-69; 94-99; 130-136. 1936. **27**: 20-24; 51-56. 1937.

Wherry, E. T. *Guide to Eastern Ferns.* Science Press, Lancaster, Penn. 1937.

THE ASCORBIC ACID CONTENT OF SOME MARITIME PROVINCE FOODS

Barbara C. Collier, Mary F. MacK. Morrison
and Margaret E. Morse

Dept. of Household Economics, Acadia University
Wolfville, N. S.

(Received June 27, 1941)

ABSTRACT

Determinations of ascorbic acid, and in some cases of ascorbic acid plus dehydroascorbic acid, in potatoes from Maritime Province sources, cooked in various ways, of commercial tomato juice and canned tomatoes sold locally, of home canned tomatoes and of several varieties of Annapolis Valley apples are given. For the most part the values found are within previously determined normals for potato, tomato and apple.

Large numbers of determinations of the 1-ascorbic acid (Vitamin C) and dehydroascorbic acid content of foods by titration methods have been published in recent years. The studies reported here—abstracted from Senior Theses—were made to compare some locally grown fruits and vegetables with citrus fruits as a source of vitamin C, and to study the effect of various cooking processes on the vitamin.

Method

The method used in general was that described by Burrell and Ebright (1940). A twenty gram sample of the material to be analyzed was mixed with 15 ml. of 2N sulphuric acid and 15 ml. of 4 per cent metaphosphoric acid and the mixture was ground in a porcelain mortar with acid-washed sand if solid material was present. It was then made up to a standard volume, centrifuged, and aliquots of the clear liquid, measured with a small pipette, were titrated. In some cases, in order to determine also dehydroascorbic acid, which is physiologically active in the same way as 1-ascorbic acid, the material ground with the mixed acids was saturated with hydrogen sulphide to reduce dehydroascorbic acid to ascorbic acid, allowed to stand over night, and then washed with carbon dioxide for half an hour to wash out all remaining hydrogen sulphfde before centrifuging and titrating.

The titrations were made with 0.001 molar solution of the dye sodium 2, 6-dichlorobenzenoneindophenol made up fresh at least once a week with 2 ml. of fifteenth molar phosphate buffer of pH 6.8 in 100 ml. of the solution, and standardized usually iodometrically (Menaker and Guerrant, 1938) against a 0.01 normal solution of thiosulphate the primary standard for which was the best grade of arsenic trioxide. The dye was standardized also in some cases against Merck's Cebione (pure 1-ascorbic acid) (Clayton and Folsom, 1940).

The titrations of the samples of the fruit or vegetable extracts were made at room temperature by adding the dye from a Folin 5 ml. burette to the sample contained in a 50 ml. Erlenmeyer flask until the pink color of the dye (in acid solution) persisted for a few seconds.

The Potato

Experiments by B. C. C.

The destructive action of the enzyme ascorbic acid oxidase on ascorbic acid starts as soon as the potato is dug, and continues until the enzyme is inactivated by heat. The destruction of the vitamin takes place most rapidly during the first few minutes of heating before the enzyme is destroyed. The method of cooking, therefore, has a great effect on the vitamin C content of the cooked potato.

In this study, medium sized, firm, well-shaped potatoes were chosen and a great deal of care was taken with their preparation, to insure the best possible results.

The baking was done in an electric oven at 400°F. for fifty minutes. The baked potatoes were allowed to stand in their skins for twenty minutes, and then portions of two potatoes were extracted separately as quickly as possible with the acid mixture. Three aliquots from each extract were titrated.

The boiling was done by dropping the whole potato into three cupfuls of vigorously boiling water and continuing to boil for fifty minutes. The boiling with salt was done in the same way except that ½ teaspoonful of salt was added. Potatoes were also boiled in halves with the other conditions unchanged. Vitamin C retention per gram was about half that for the whole potato. This is because a larger proportion of the vitamin passes into the water. Olliver (1936) found that by the time cooking is completed the vitamin is usually fairly evenly distributed throughout the solid and liquid.

The French fried potatoes were cut in eighths lengthwise, and fried in deep shortening for ten minutes, drained from fat on soft paper and sprinkled with salt.

The method of analysis was the same in all cases.

The results expressed in milligrams of ascorbic acid per 100 grams of the cooked potato are given in Table I.

TABLE I

	French Fried	Baked	Boiled whole with Salt	Boiled whole without Salt
N. B. Green Mountain....	18.0	13.8	11.2	6.3
Cape Breton Pink Eye....	16.1	11.9	10.9	5.9
N. S. Green Mountain....	15.9	10.9	8.9	5.3
N. B. Sebago............	15.3	8.2	8.2	5.2
N. B. Katahdn..........	14.0	8.2	8.0	5.0
N. S. Cobbler...........	13.2	8.0	7.4	4.3
N. S. Bliss Triumph......	9.5	5.9	5.9	4.2

The analyses in Table I were made without reduction by hydrogen sulphide. Such reduction of the baked N. B. Green Mountain variety resulted in an increase in ascorbic acid amounting to 3 mg. per 100 grams.

It will be noticed that the order of ascorbic acid retention for the different methods of cooking is the same for each of the seven varieties.

The experiments were made in February and March. Storage reduces the vitamin C content of the potato. It is probable that the difference between the varieties was due largely to difference in storage conditions. The New Brunswick potatoes were grown from certified seed, were graded, were intended for use as seed and were obtained from a warehouse in Victoria County, N. B., shortly before analysis. The Cape Breton potatoes, also, were grown from certified seed and were graded. The other Nova Scotia potatoes were grown from uncertified seed and were ungraded.

An attempt was made to determine the ascorbic acid content of the raw potato in the case of each variety. The order of ascorbic acid content found for the different varieties was the same when raw as when cooked. Inasmuch as it is difficult to break down the hard uncooked tissues by grinding with sand and the acid mixture in a porcelain mortar and prepare a uniform sample for analysis, the actual weights obtained are not listed here.

THE TOMATO

Experiments by M. F. McK. M.

Ascorbic acid determinations were made on five brands of tomato juice and one brand of canned tomatoes purchased in local stores, on tomatoes grown locally and canned in tins by a Women's Institute and in glass by members of a Household Economics class, and on raw tomatoes imported in February. The tomato juice and the commercially canned tomatoes originated in the Provinces of Ontario and Quebec. In the case of each brand, analyses were made on the contents of two or three newly opened cans, and the effects of heating, and in some cases of adding soda and heating, and of exposure to air, on the ascorbic acid content were investigated also.

The results with tomato juice are given in Table II, those with canned and raw tomatoes in Table III.

TABLE II

Milligrams of Ascorbic Acid per 100 grams of Tomato Juice

		Newly Opened	Heated in Pyrex	Exposed to Air
Brand A.	1st. can........	19.1	14.6	
	2nd. "	17.2	....	10.9 (after 1½ hrs.)
Brand B.	1st. "	21.1	....	
	2nd. "	19.8	20.7	
Brand C.	1st. "	14.7	....	11.3 (after 2 days)
	2nd. "	26.6	....	
Brand D.	1st. "	14.5	18.1	
	2nd. "	17.8	....	
Brand E.	1st. "	13.3	14.9	
	2nd. "	14.7	....	13.6 (after 1½ hrs.)

TABLE III

Milligrams of Ascorbic Acid per 100 grams of Tomatoes

	Newly Opened	Heated in Pyrex	Heated with Soda	Exposed to Air
Commercially canned...	17.0	17.1	16.6	
Home canned in glass...	22.1	22.1	....	14.7 (2 days)
" " " " ...	....	....	....	4.5 (1 week)
" " " tins....	15.5	21.	19.2	
Raw imported tomatoes.	23.1	....	....	

Discussion of Results

The proportion of ascorbic acid in the canned tomatoes and tomato juice was found to be in general a third or a quarter of that in fresh citrus fruit juice which is usually found to contain between 50 and 65 mg. per 100 ml. The loss of ascorbic acid on exposure to air is due to oxidation. Loss by oxidation on heating might be expected, especially when the acidity is reduced by the addition of soda, but the reverse effect, found in about half the experiments, has been observed frequently by others. McHenry and Graham (1935) suggested in explanation "that a part of the ascorbic acid in the tissue is bound to some other substance and that this combination is split by hydrolysis." Our glass packed tomatoes were particularly high in ascorbic acid, but extensive studies by Lueck and Pilcher (1941) have shown "that vitamin C was retained in higher degree in the product packed in tin containers than in the identical tomato juice packed in glass bottles." This is attributed to the reducing conditions maintained by the tin plate.

The Apple

Experiments by M. E. M.

The apples used were grown in the Annapolis Valley. They were all obtained from the same warehouse shortly before analyses. The work was done between the 25th of February and the 24th of March.

Radial sections of the raw apples, excluding the inedible parts but including the peel, were taken for analyses. The rest of the method of analyses was the same as that for the cooked potatoes.

The results in milligrams of ascorbic acid per 100 grams of apple are as follows: Golden Russett, 14.5; Ben Davis, 13.4; Red Spy, 11.9; Baldwin, 10.9; Gano, 8.6; Greening, 5.8; apple sauce from Ben Davis apples which had been soaked over night in 2½ per cent salt solution to exhaust respiratory oxygen, 7; apple sauce from the same apples without the treatment with salt water, 3.7.

Analyses, with hydrogen sulphide reduction, of several brands of canned apple juice, showed that almost all of the ascorbic acid had been irreversibly oxidized.

Acknowledgments

The authors are indebted to Mr. Donald M. McLean for an extensive library and laboratory study of methods of vitamin C titration, and to Miss Gertrude Mahaney for some preliminary analyses checked by feeding experiments with guinea pigs.

REFERENCES

Burrell, R. C. and V. R. Ebright. *J. Chem. Ed.*, 17:180-182. 1940.

Clayton, M. M. and M. I. Folsom. *J. Home Econ.*, 32:390-395. 1940.

Lueck, R. H. and R. W. Pilcher. *J. Ind. Eng. Chem.*, 33:296. 1941.

McHenry, E. W. and M. Graham. *Biochem. J.*, 29:2017. 1935; also H. Reynolds, *Chem. Abs.*, 35:1531. 1941.

Menaker, M. H. and N. B. Guerrant. *Ind. Eng. Chem. Anal. Ed.*, 30:25-26. 1938.

Olliver, M. *J. Soc. Chem. Ind.* 55: 153. 1936.

SOME RECENT ASPECTS OF GENETICS

PROF. R. RUGGLES GATES, F.R.S.
University of London, King's College

(An Address delivered before the N. S. Institute of Science,
September 26, 1941.)

The rise of genetics has been the most outstanding feature in the development of biology during the present century. The main credit for the rediscovery of the Mendelian laws of heredity in 1900 is due to deVries. It happened that at that time the study of chromosomes had reached a point where it was recognized almost immediately that their behaviour in the germ cells of plants and animals furnished the necessary mechanism for just this type of hereditary behaviour. The independent segregation of the members of each chromosome pair was soon recognized as determining the segregation of characters which is witnessed in the second generation from a hybrid cross. This greatly strengthened the view, which had long been tentatively held, that the chromosomes furnish the material basis of heredity, i.e., of genetic continuity from cell to cell and from generation to generation. Without this stable self-perpetuating mechanism in the nuclei of every cell, the phenomena of heredity in the infinite complexity of organic structure would be impossible.

Various lines of experimental evidence have since proved the essential part played by the chromosomes. One of the earliest of these consisted in showing that *Oenothera lata*, a mutation originally discovered by deVries among the offspring of *O. Lamarckiana*, always had 15 chromosomes, the duplication of one chromosome accounting for the peculiar features of leaf, flower and habit which are invariably present in this mutant. The same broad-leaved mutation has since been found arising from various other species, and the recognition of this fact in 1912 constituted the discovery of the principle of parallel mutations. This principle has become one of great evolutionary importance, whose significance is not even yet fully recognized.

Before it was known that what are now called trisomic mutations (with an extra chromosome) existed, the process of non-disjunction, or failure of one pair to separate in meiosis, giving one daughter cell with 8 chromosomes and one with 6, had been discovered in *Oenothera rubrinervis* (Gates, 1908). Some years later the same process was observed in Drosophila. In Datura, which has 12 pairs of chromosomes, the corresponding twelve trisomic mutations have all been discovered by Blakeslee and his colleagues (1934) and investigated in full detail.

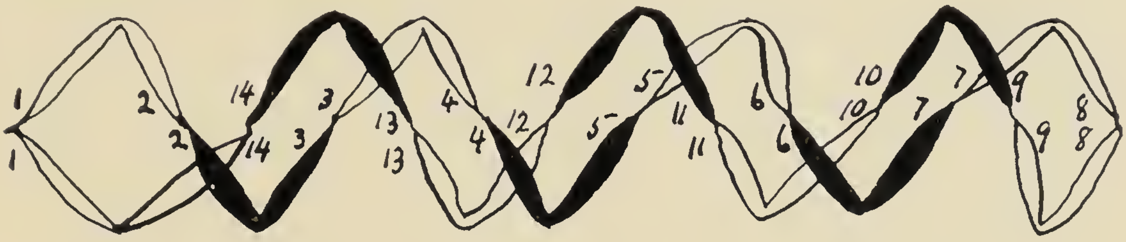
It has since been shown that the chromosomes of most *Oenothera* species are linked together into one or more rings in meiosis. Similar conditions (catenation) of the chromosomes have since been observed in various other genera of plants, including Pisum, Campanula and Gaura. This condition has arisen through interchange of ends between two different pairs of chromosomes, followed by crossing with the original form in which such interchange had not taken place.

Later investigations lead to the view that each of these chromosomes which are linked end-to-end is homologous with a different chromosome as regards each of its ends, while the middle portion (around the spindle fibre attachment) is differential as between the two members of a pair, i.e., two consecutive chromosomes in the ring, each chromosome having thus a fixed position in the ring (see Fig. 1). Since consecutive chromosomes normally go into separate nuclei in the reduction division of this zigzag ring of chromosomes, two types of pollen grain and egg cell are produced in equal numbers by this separation. Generally one type of pollen and the other type of egg (embryo sac) are non-viable, and so the species continues to breed true although it is in a hybrid or heterozygous condition.

The two ends of each chromosome are now denoted by numbers, so that a species with a ring of 14 may be written

```
(1.2    3.4    5.6    7.8    9.10      11.12      13.14
   \   /   \   /   \   /   \   /    \      /    \     /    \
    2.3    4.5    6.7    8.9      10.11      12.13        14.1)
```

In simple non-disjunction any two consecutive chromosomes may go to the same pole. At the moment of separation they appear as in Fig. 1.



One of my staff (Catcheside, 1936) has shown that in *O. Lamarckiana*, which has a ring of 12 and one free pair of chromosomes, there are three cytological types of non-disjunction, each giving 12 different 8-chromosome gametes, making 36 different types of such gametes in all. These are functional only on the female side, but each can combine with either a *velans* or a *gaudens*,[1] pollen grain, giving 72 possible trisomic types. In addition, one other trisomic type can arise when both members of the free pair of chromosomes goes to the same pole. These 72 possible trisomics belong in six different cytological classes and five of these classes will breed true notwithstanding the presence of the extra chromosome. Many of these mutations have been observed and analyzed, although some are no doubt non-viable.

Another of my colleagues (Ford, 1936) showed that in an *Oenothera* with a ring of 14 chromosomes (and this is the condition in all the Canadian species so far as we know) 49 types of 8-chromosome gametes are possible. As these normally function only on the female side but can mate with both types of pollen, there are 98 possible 15-chromosome zygotes from such a species. They fall into seven classes, six of which are monomorphic or breed true, while the other is dimorphic, giving both the mutant and the parent type in their offspring. Probably many of these are non-viable; nevertheless a number of such mutants from wild Canadian species have been investigated in my cultures.

---

[1] These are the names of the two kinds of gametes which arise in *O. Lamarckiana* from segregation of the chromosomes as described in the last paragraph.

From time to time an interchange of ends has taken place between two chromosomes, as already mentioned. Thus 2.3 might interchange with 7.8, producing two new chromosomes 2.7 and 3.8 or 2.8 and 3.7. When a gamete in which this has occurred mates with a normal one new linkages of the chromosomes are produced. By elaborate series of crosses between forms whose chromosome ends are identified and forms in which they are unknown, the arrangement of the ends in a series of species, and hence their evolutionary origin and relationship, can ultimately be determined by the various rings and pairs they form in each hybrid. This slow and laborious work is now in progress (Catcheside, 1940) and will ultimately lead to a full genetic analysis of the many species of *Oenothera*.

Since 1932 I have been conducting a genetic survey of the genus *Oenothera* in Eastern Canada, including the Maritimes, Quebec and Ontario as well as some from the adjacent States and Western Canada. Hundreds of cultures have been grown from seeds collected by myself or sent to me by friends and correspondents. The results of three years' cultures have been published in a monograph (Gates, 1936) in which many new species and varieties were described. Since then many other new forms have been studied and a mass of material is awaiting publication, this work having been suspended owing to the war.

The resulting general evolutionary picture is that of a genus which has been rapidly evolving as the vegetation moved northwards on the American continent, following the retreat of the ice. The primitive condition in the south was that of a species with large flowers and seven free pairs of chromosomes. The small flowers of Canadian species have since developed, apparently by a series of dominant mutations. Linkage or catenation of the chromosomes appears to have resulted in nature from exchange of chromsome ends followed by crossing, thus producing larger and larger rings and finally a ring of 14. These ring arrangements became stabilised by the development of a balanced lethal condition in which only certain gametic types are able to survive. In the meantime numerous other gene mutations affecting various parts of the plant have occurred. These, together with the occasional occurrence of hybrids, which breed true owing to the mechanism we have already briefly explained, will account for the great diversity of *Oenothera* forms now found scattered over most of the continent.

One other of the many genetic peculiarities of *Oenothera* may be mentioned, because it has a bearing on much of the cytological research which has been developed in my Laboratory in recent years. The most primitive species of *Oenothera*, *O. Hookeri*, and all other species examined (with one exception), although they only have 14 chromosomes, which is an ordinary diploid number, yet have two pairs of nucleoli (Badhuri, 1940). Formerly it was supposed that the number of nucleoli in the cells of an organism was of no significance. Now we know from much cytological work on many plant genera both in my Laboratory and in various others, that the nucleoli arise from particular chromosomes in the cell and that the number of pairs of nucleoli together with the number, size and shape of the chromosomes can be used in tracing the phylogeny from species to species in a genus and even in larger groups.

The evidence shows that one pair of nucleolar chromosomes is necessary in every active cell. The presence of two pairs in rice plants shows, together with several other lines of evidence (see Ramanujam, 1938), that the 12 pairs of chromosomes in cultivated rice have been derived from an ancestral condition in which there were five pairs. It may be that in *Oenothera* also the seven pairs of chromosomes are derived from a lower ancestral number, but there are other possibilities regarding the significance of the two pairs of nucleoli in *Oenothera*. For instance, this may represent a stabilized condition in which the functions of the two pairs of nucleoli are differentiated in the life of the cell (see Gates, 1942). In any case, it is clear that the two pairs have existed throughout the whole evolutionary history of this genus.

Before leaving the subject of plant genetics I ought to say that some years before the war we developed in Regent's Park, London, a Laboratory for the genetical investigation of plants. Research was carried out here on many tropical and temperate economic plants such as rice, cotton, wheat, tora, as well as others, such as *Oenothera*, of purely scientific interest.

To avoid wearying you by further details of plant genetics and cytology, let us pass to a brief consideration of some features in the genetics of man himself. This is a subject with which I have long been concerned. It leads one into the fields of anthropology, racial crossing, population, eugenics, blood groups, mental inheritance, and medicine, especially in their genetical aspects. "Heredity in Man" (1929) summarized our knowledge of human genetics up to a decade ago. The Bureau of Human Heredity was founded in London about 1935 to continue the accumulation, filing and abstracting of all papers, books and other data on human inheritance as fast as they appeared. This work is being continued on a reduced scale during the war.

It was formerly said, sometimes even by geneticists, that the laws of Mendelian inheritance do not apply strictly to mankind, although we know that he has the same chromosome mechanism as other organisms. Such views are, however, no longer tenable, and I believe that all who know the facts and complications of modern genetics are now agreed that the same principles apply universally to man as to other organisms. All human races, so far as known, have 48 chromosomes, including an XY pair of sex chromosomes. Such features as colour blindness and haemophilia are sex-linked in inheritance because they have arisen as mutations in the X-chromosome. It has recently been shown that these conditions are, as would be expected, linked with each other. Thus the sons of a woman who is normal but is a transmitter of both colour-blindness and haemophilia, because they are present as recessive mutations in one of her X-chromosomes will usually have both conditions or be free from both. But occasionally, owing to a cross-over between the two X-chromosomes, these conditions will be separated. Then some sons will have one condition and some the other.

The Y-chromosome is the smallest of all, and in most organisms it contains few or no genes. It is transmitted directly from father to son, because its presence determines a male individual. The genes it contains will then be inherited in the same way, but this male-to-male type of inheritance is rare because the Y contains so few genes. Webbed toes appear to be inherited in this way, however, in certain pedigrees. In most animals this type of inheritance is also rare, but in certain fishes Winge (1927) has shown that a series of genes determining colour patterns are in the Y-chromosome and they occasionally cross over with the X. Another rare form of inheritance is directly from mother to daughter only. This type of inheritance of colour-blindness was found in a Belgian family over a century ago. The same female-to-female inheritance was discovered in a strain of the fruit fly, *Drosophila melanogaster*, and was shown (see L. V. Morgan, 1938) to be due to a linking together end-to-end of the two X-chromosomes in the female. Such cases as these give an indication of the irregularities in chromosome behaviour which may be found in man with future investigation.

The 24 pairs of chromosomes in man is a relatively high number, although certain monkeys have more. In *Drosophila melanogaster*, which has only four pairs of chromosomes, all the genetic differences or mutations, of which some 500 are known, have to fit into four linkage groups, because all genes in the same chromosome will be linked with each other. Similarly, among plants, the sweet pea, with seven pairs of chromosomes, has been shown to have seven linkage groups, and maize, with ten pairs, ten linkage groups. In man, on the other hand, there will be 24 linkage groups. The known genes may be scattered in all these pairs, with the result that very few are likely to be found in the same chromosome pair until the linkage relations of a large number of genetic characters have been investigated. We have already seen that sex-linked characters, being in the same chromosome, are linked with each other.

Proved cases of linkage of genes in other chromosomes are still rare. The evidence on this head has been mostly negative up to now. For instance, it has been found that the blood group, eye colour, recessive polydactyly and telangiectasis are all due to genes located in separate chromosome pairs. Similarly, using recently developed statistical methods, it has been shown that brachydactyly, blood group, Friedrich's ataxia and taste blindness to phenyl-thio-carbamide are probably in separate chromosomes. Again it has been shown that the ABO blood groups, the MN blood types, eye colour and allergy are independently transmitted. On the other hand, by what is known as the paired sib method, linkage has been found between (1) eye colour and myopia, (2) hair colour and absence of certain teeth. There is also a well-known pedigree in which the individuals with black hair have a crooked little finger and those with blond hair a straight little finger. This could only be accounted for by the genes for these two unrelated conditions residing in the same chromosome.

The types of characters whose inheritance we have thus far considered have been mainly of interest and importance from a medical and a eugenic point of view. Racial characters are also of course inherited, and this is a matter for the anthropologist. The characters we have been considering are simple unit differences and each has probably arisen as a single mutation. Racial differences, on the other hand—and this is found to be true both in man and in the higher animals—are generally represented by multiple factors. Stature, a racial characteristic, is analyzable into a whole series of length factors with genic determination. Blue and brown eyes can be treated as a simple factor-pair with brown dominant to blue. But although the matter still awaits full analysis, a series of minor factors undoubtedly determine intermediate degrees and patterns of iris pigmentation. The cephalic index or length-breadth index of the head has been regarded by anthropologists as a most characteristic racial feature. Thousands of heads and skulls have been measured all over the world. Yet we know very little of the genetics of head-shape and no race is uniform in its cephalic index. But from what is known of the inheritance of shape in such fruits as pumpkins, squashes, and gourds, where a few genetic factors determine the shape, it is clear that the human head is a much more complex problem and that much has to be done before the inheritance of human headshape can be understood.

Skin colour is one of the most characteristic racial differences. Crosses between whites and blacks and Indians indicate that in addition to two main factors which are additive in their effects, there is at least a third which produces a small amount of pigment in excess of the brunet. In my view, the white race has arisen from a dark-skinned race through several mutations in loss of pigmentation from skin, eyes and hair. The Nordic race, with fair hair, blue eyes and a fair complexion, represents the last stage (except the albino) in this process of depigmentation. The African negro, with intensely dark skin, hair and eyes, represents the other extreme, of adaptation to tropical conditions. In the temperate zone there is no advantage in relation to climate in having blue or brown eyes, blond or brunet complexion, but in the tropics it appears that Nordic coloration is a definite disadvantage. The glands of the negro skin and his relative hairlessness are also probably adaptations to tropical climate. The broad, flaring nostrils have been regarded as an adaptation to breathing warm, moist air, as the narrow nasal passages of the Eskimo are adaptive to cold arctic conditions.

It appears, however, that hair shape and most other racial differences have no adaptive value. It is significant that kinky hair has appeared as a dominant parallel mutation and been inherited through several generations in a Norwegian family and also in a family in Holland of pure European descent. They showed no negroid characters. Probably the kinky hair of the negro arose in the same way, and later spread to become a racial character. In crosses, the kinky hair of the negro is dominant, as are the broad nose, prognathous jaw and other features, but genetic segregation of all these and other differences occurs in later generations. Even the recessive white skin colour segregates, and every year both in South Africa and the United States thousands of these segregates are near enough to the white type to "pass for white". The most striking case of this kind I have seen was in a descendant from a cross between a Nordic Dane and an Eskimo woman in Alaska. One of the daughters married another Nordic. I photographed the mother and two of her daughters on Great Slave Lake (see Gates, 1929, p. 337). One of these daughters was intermediate in coloration like her mother. The other, while having some Eskimo features, had a white skin, blue eyes and fair hair. From such cases there can be little doubt that racial differences segregate in crosses in the strictly Mendelian fashion.

Having long been interested in the genetics of the Canadian Indian tribes, and having made studies of various British Columbia Coastal tribes (Gates and Darby, 1934), of Ojibway mixed-breeds in Northern Ontario (Gates, 1928) and of Micmac mixtures in Nova Scotia (1938), I might refer for a moment to a few of the genetic conclusions gleaned from those studies: (1) The "black" Indian eye has a dominant intensifying factor which is not present in Europeans. Even Indian babies show the intense black eye colour. (2) In Indians of mixed European descent the degree of pigmentation in skin, hair and eye colour generally corresponds within rather narrow limits. (3) Some genetic factors for eye colour are however, independent (partially linked) of some factors for skin colour. (4) While the kinky hair of the negro is strongly dominant to the straight hair of the Indian, it is not clear that any dominance is involved as between the straight hair and the wavy or curly hair of Europeans. The genetics of these hair characters can only be cleared up by fuller detailed observations. In Indian-white mixtures straight hair is much less frequent than black hair and eyes or dark skin.

A word may be permitted regarding the racial significance of the human blood groups. My interest in them arose from the fact that they are sharply marked unit differences, A and B both being inherited as simple dominants to O. While their genetics is therefore known, the reason for the wide differences in the frequencies of A, B, AB and O in different races have been much discussed, and hundreds of thousands of tests have been made of races in all parts of the world, without unanimity being reached as to the cause of these diversities. A general survey of the subject was made (Gates, 1936a) and numerous reports have been published as Secretary of a British Association Committee for the blood grouping of primitive peoples (see Brit. Assoc. Annual Reports). Results have been obtained, not only from the Canadian Indian tribes already mentioned and from Eskimos, but also from various other parts of the world. Several people were set to work among the many primitive tribes of India, but most of this work came to an end when the war began.

The racial significance of blood groups is too lengthy a subject to discuss here. My own views on this subject have developed gradually during the last decade. It appears to be clear that natural selection has played no part in the distribution of the A and B. I take the view that O was the primitive condition, from which A and afterwards B developed as dominant mutations. Since about 40% of A and little or no B is present in such primitive peoples as the Australian aborigines, the South African Bushmen, the Basques of Western Europe and the arctic Lapps, the A must have been derived from our anthropoid ancestors, all four genera of which have it. It is true that such a condition can accumulate simply through repeated mutation in the absence of any selective effect. But the time required would be excessive unless we assumed considerably higher mutation rates than are known to exist in other cases.

As regards the origin of the B blood group, it has been shown to differ from the B of the gorilla and cannot reasonably be derived from an anthropoid ancestor. It has then probably arisen independently in the human line of ancestry as a parallel mutation. It seems to have been more recent than A in its development and is highest in Eastern Asia and India where it reaches about 35% in Mongolia and in the Hindu population. The native jungle tribes of India are often very different in their blood group percentages. It would seem, then, that the spread of the blood groups could be accounted for by their manner of inheritance, accompanied by racial migrations, racial crossing which has frequently taken place in the past, and a low mutation rate.

The problem of the American Indian blood groups is one by itself. Until a few years ago the evidence indicated that the American Indians were originally O. This raised a difficulty, because anthropologists are agreed that the Indians came across from Asia either towards or after the end of the Ice Age, and the Mongoloids, from whom they are believed to be derived, now have a high percentage of both A and B. A tentative solution of this dilemma was suggested (Gates and Darby, 1934) in our study of the Kwakiutls, Haidas and other British Columbia coastal tribes. Since then it has been found (Matson and Schrader, 1933) that the Blackfeet and Blood Indians of Montana and Alberta have a very high percentage of A individuals. This may even reach 80%. Have they derived this A from their Asiatic ancestors, or has it accumulated through a high mutation rate (O to A), or is it simply a chance result through the isolation of a few ancestors who had the A and produced the present population? Before these questions can be answered it will be necessary to blood group more tribes in the Canadian Northwest and in Alaska, as well as in Siberia. But it will be seen that the blood groups can throw a clear light on the origin and history of a race. When combined with the study of other anthropological characters they can be of much value in determining relationships and racial history.

Finally, while we have been discussing purely scientific questions of racial history and origin and human genetics, it seems desirable to point out that the facts of human genetics all have a practical bearing on our own lives. The study of eugenics was founded by Galton as a means of improving the human race by taking thought of ancestry and recognizing the importance of heredity. Genetic evidence makes it clear that not only physical but mental differences are inherited, although there has not been time to discuss this aspect. An aim of society should be so to regulate social conditions that those of superior ability in every walk of life should have a better opportunity to perpetuate their kind. Feeblemindedness and other forms of mental defect are generally inherited. They represent unfortunate mutations which have occurred in the germplasm, sometimes many generations previously, as feeblemindedness is recessive in its inheritance. Improvement of the conditions of living is of course a desirable aim, but it should not be forgotten that improvement or even maintenance of the stock cannot take place in this way. Hardship may purge a race of its weaker elements, but soft living is more likely to lead to racial decay.

LITERATURE CITED

Bhaduri, P. N. Cytological studies in Oenothera with special reference to the relation of chromosomes to nucleoli. *Proc. Roy. Soc.* B. **128**: 353-378. 1940.

Blakeslee, A. F. New Jimson weeds from old chromosomes. *Journ. Hered.* **25**: 81-108. 1934.

Catcheside, D. G. Origin, nature and breeding behaviour of *Oenothera Lamarckiana* trisomics. *Journ. Genet.* **33**: 1-23. 1936.

——— Structural analysis of Oenothera complexes. *Proc. Roy. Soc.* B. **128**: 509-535. 1940.

Ford, C. E. Non-disjunction in Oenothera and the genesis of trisomics. *Journ. Genet.* **33**: 275-303. 1936.

Gates, R. Ruggles. A study of reduction in *Oenothera rubrinervis*. *Bot. Gaz.* **46**: 1-34. 1908.

——— A pedigree study of Amerindian crosses in Canada. *Journ. Roy. Anthrop. Inst.* **58**: 511-532. 1928.

——— Heredity in Man. Constable: London and New York. 1929.

——— Genetical and taxonomic investigations in the genus Oenothera. *Phil. Trans. Roy. Soc.* B. **226**: 239-355. 1936.

——— Recent progress in blood group investigations. *Genetica* **18**: 47-65. 1936a.

—— The blood groups and other features of the Micmac Indians. *Journ. Roy. Anthrop. Inst.* **68**: 283-298. 1938.

—— Nucleoli and related nuclear structures. (In press). 1942.

Gates, R. R. and Darby, G. E. Blood groups and physiognomy of British Columbia coastal Indians. *Journ. Roy. Anthrop. Inst.* **64**: 23-44. 1934.

Matson, G. A. and Schrader, H. F. Blood grouping among the "Blackfeet" and "Blood" tribes of American Indians. *Journ. Immunol.* **25**: 155-163. 1933.

Morgan, L. V. Origin of attached-X chromosomes in *Drosophila melanogaster* and the occurrence of non-disjunction of X's in the male. *Amer. Nat.* **72**: 434-446. 1938.

Ramanujam, S. Chromosome studies in the Oryzeae. *Ann. Botany* N. S. **2**: 107-125. 1938.

Winge, O. The location of eighteen genes in *Lebistes reticulatus*. *Journ. Genet.* **18**: 1-43. 1927.

PRESIDENTIAL ADDRESS

Harold S. King

(Read October 14, 1940)

A year ago we had with us at our Annual Meeting a member who for more than fifty years had given to the Institute his time and devotion. Mr. Piers took an active part in the discussions of that meeting. Little did we realize that his place would soon be vacant. The sense of loss which the Institute feels was expressed in a motion passed at the February meeting. This motion is published in the Proceedings. It is fitting to add here that in the years I have served on the Council with Mr. Piers, I have valued greatly his critical faculty which has acted as a brake on the impetuosity of us newer members, often to the advantage of the Institute. The flavour of our meetings will in the future lack the salt of his personality.

It is customary for the President in his annual address to sum up the year's activities and development with comments of a constructive nature for guidance in the future.

During the year under review there were elected five ordinary members, one associate member and eight student members. Evidently one of the duties of the incoming Council should be a drive for increased membership. Certain people interested in science would undoubtedly join if the present advantages of membership were brought to their attention. Others would become members if the meetings were made sufficiently attractive.

At the six ordinary meetings held during the year, there were presented 13 papers and 3 demonstrations. The papers were distributed among the sciences as follows: three in biochemistry, two each in physiology and ichthyology and one each in bacteriology, botany, industrial chemistry, physical chemistry, embryology and physics. The attendance at these meetings ranged from 13 to 30 with an average of 23.

To increase the value and attractiveness of ordinary meetings, the Council is experimenting with the serving of refreshments after the programme of the evening. It is to be hoped that worth-while informal discussions will be developed over the tea cups. This innovation was started successfully last year and will be tried again this year. Whether refreshments take a permanent place at our meetings depends on the results.

During the last two decades the activities of the Institute have been becoming more and more concerned with specialized science, its membership composed very largely of professional scientists. It is to be remembered that our society began as a Mechanics' Institute. It has been suggested by several scientific laymen that we include on the programme of each ordinary meeting one paper of a general nature, or a demonstration, that they could understand. They made it plain that it was not desired that the presentation of original research be curtailed. They wanted to know what was being done scientifically even if it were over their heads. However they did want to come from a meeting with a sense of intellectual gain.

It was also brought to my attention that a similar organization in another city performed a service for, and stimulated the interest of, mechanics and others who encounter applied science in their work but who do not have a college education. They conducted a question period after the programme of the meeting where one could ask the professional scientists questions arising out of one's work or reading—such questions as definitions of octane number, conductance or hybrid vigour, what happens in the tempering of steel or is it really necessary to watch one's vitamines. These, by the way, are only a few of the questions which have actually been put to me during the year. Such a project would necessitate the presence at each meeting of experts representative of the various sciences.

Among the military, naval and air men stationed in the Halifax area, there are undoubtedly some who would find our meetings interesting. The Council has appointed a committee to investigate the best method of inviting such members of the services to attend our ordinary meetings.

It is recognized that the meetings of the Institute are valuable chiefly to those in Halifax. The Proceedings, on the other hand, are of value throughout the Province. We like to think of them as our contribution to the scientific world. They are abstracted in the great abstract journals. Through our extensive mailing list they have been made available in every center of scientific activity in the world. The war has curtailed their distribution for the present, but we are storing sufficient copies to complete broken files when the war is won. The widespread distribution of the Proceedings is of decided value to the Institute and Province because in return we have obtained exchanges which now constitute a great proportion of the accessions of the Provincial Science Library, making it in some respects unequalled in Canada.

In 1929, following the death of Dr. A. H. MacKay, I was appointed his successor as Editor of the Proceedings. Since then I have seen twelve yearly numbers through the press. Part 2 of volume XX is now printed. I am told by the printers that it will be ready for distribution tomorrow. It is with an almost paternal reluctance, yet relief, that I herewith announce my retirement. The Editorship has involved much time and thought. I desire here to thank the Institute for the free hand it has given me in this work and for the kind appreciation with which, as an organization and individually, you have rewarded my efforts. I wish also to thank the members of the Editorial Board for their constant support and valuable assistance.

Your Council has had a very strenuous year with ten meetings. Beyond the efficient handling of the customary business, they have spent much time in drawing up the By-Laws of the Institute. A committee, composed of Dr. Weld, Dr. Hayes and your President, reviewed the regulations on the pages of the minute books and then proceeded to draw up a new code. Finally each item was carefully considered by the Council. This revision was completed in April. The combined Constitution and By-Laws were printed together in pamphlet form and mailed to each member during the summer.

The Institute, by reason of its long and intimate connection with the Provincial Museum, has always been deeply concerned with the state of the latter. Last November a committee, composed of Dr. Henderson, Dr. Hayes and your President, was appointed to study the problem. This committee brought to the December meeting a motion requesting the Government of Nova Scotia to make adequate provision for the museum and to provide for a Museum Commission to administer its affairs. This motion was passed unanimously and is printed in full in the Proceedings. In support of this action the same committee prepared a memorandum. This was forwarded to the Government. It discusses in detail the views of the Institute as to the aims and policy of the Provincial Museum. Since this memorandum expresses our views and aspirations in respect to the museum, it is desirable that it be put in permanent form. Consequently, I embody it in this address. It reads as follows:

> The Nova Scotian Institute of Science has for some years been much concerned over the overcrowded condition of the Provincial Museum in an unsuitable and non-fireproof building. It seems probable that before long a general reorganization of the Museum, not only in respect to staff, but to general aims and purposes, may be necessary. In any case, the Institute feels that a general policy in respect to the management and future development of the Museum should be formulated in the near future and with this in view considers that the best interests of the Museum would be furthered by the establishment of a commission under the authority of the Minister of Mines with the duty of formulating the policy and of administering the affairs of the Museum. It is suggested that this commission be composed of members selected from the following:
>
> Deputy Minister of Mines, Ex-Officio Chairman
> Deputy Minister of Public Works
> The Superintendent of Education
> The President of the Technical College
> The President of the Agricultural College
> Two nominees of the Nova Scotian Institute of Science
> One nominee of the Maritime Universities' Conference
> One nominee of the Nova Scotia Historical Society
> The Provincial Archivist
> One or two private citizens such as Dr. F. W. Gray, etc.
>
> In order to make clear the views of the Institute, it is thought that a rather detailed statement will be pertinent and helpful. These

views may be classified under the following headings: (1) the purposes of the Museum, (2) the qualifications desirable in a curator, (3) the housing of the Museum and (4) the relation between the Museum and the Institute.

1. *The Purposes of the Provincial Museum.*

A museum serving the Province as a whole must have a multiplicity of services to perform. S. F. Markham, in his report on the Museums of the British Isles, has stated that the main functions of a museum are conservation, research and visual education. The first great function of the museum is to collect and conserve in an unimpaired state objects of scientific importance as a heritage for future generations in this Province. If conservation be the first function of museums, then research is of almost equal importance, for in this one word is combined the study of the collected objects, whether by the Museum staff or by visiting scientists; the classification of material; and the publication of the results achieved. The treasures of the Museum should be identified, labelled and arranged in such a way as to make them reference collections of original material, forming a comprehensive survey of all the natural resources of the Province. The third function is visual education, and in this capacity the museum can teach more about certain things in a few minutes than the best illustrated books or the most skillful of teachers can do in a much longer period. The Institute wishes to stress the fact that educational work should be a very important function of the Museum. It is unquestionably true that owing to overcrowding and lack of trained assistance this function has been inadequately fulfilled.

The Museum as it is now constituted contains many valuable specimens but owing to overcrowding cannot give the visitor a proper insight into the resources of the Province and the research worker material for study. The tourist interested in birds, minerals or other fields of natural history should be able to see without difficulty what the Province offers in the line of his special interest. The scientific worker, seeking, for example, the types of diatomes best suited for some special industrial application, should be able to get the necessary information without delay.

Other museums have found that visitors, both local and foreign, are attracted by seasonal displays of the common wildflowers of the region. This idea might be extended to include aquaria showing the game fish, hatching salmon eggs, etc., a collection of native snakes, exhibits of the mining and industrial life of the Province. The visitor should have an opportunity not only for asking questions concerning the exhibits but for advice as to points of scientific interest throughout the Province which he might wish to see for himself.

The Museum should take an active part in the intellectual life of the Province not only in holding lectures, moving pictures, etc., of scientific character but in arranging well selected and suitable collections to be loaned to schools or other interested bodies. A distinct effort should be made to distribute exhibits to town and rural schools. A group of named specimens of typical rocks of the Province with an accompanying map showing where they are to be found would teach school children much concerning their Province. Many children would appreciate a view of a case of the common birds accompanied by a map showing their migrations. These are but random examples of what can be done in an educational way by the Museum.

Moreover, the Museum should take an active part in the scientific utilization of the resources of the Province, particularly by bringing essential data to the attention of those who can best make use of them. For example, the Museum should be so organized as to be able to notify the N. S. Economic Council of the presence of valuable resources which could be developed to the benefit of the Province.

In conclusion, the Museum must be alive, modern, scientific and interesting, a pride to the citizens and an attraction to visitors.

2. *Qualifications Desirable in a Curator.*

Looking to the time when it will be necessary to appoint a new curator, the Institute feels that it will be of help to point out now, for the information of those responsible for the appointment, those qualities which would make for the best interests of the Museum and of the Province. The ideal qualifications have been set down by Sir Henry Miers and are so multitudinous that it is doubtful if all can be combined in one man. Primarily he should be a university graduate trained in science and with experience in research and instruction. He should have good administrative ability. The collecting type of mind is necessary if the museum is to grow, and judgment is needed to build up the museum as a whole. It is not necessary that he be an expert in all lines of science but, the more fields in which he has had some experience, the wider the acquaintance he has among scientists of all brands, the more valuable he will be. He need not know all the facts, but he should know where to look or inquire for them. The ability to convey his knowledge in an interesting and understandable manner is desirable. He should be familiar with the technical methods for the recording and preservation of scientific specimens. Perhaps we can best express our opinion as to the type of man required by suggesting that he should, in his sphere, hold a position corresponding to that of the Provincial Archivist, with like salary, rank, staff and responsibility.

3. *The Housing of the Museum.*

The overcrowding of the Museum is too well known to require more than the plea that, as soon as it is possible, provision be made for more space. May we quote from the 1932 report of Sir Henry Miers on "The Museums of Canada": "The only bright spots in the Maritime Provinces are the new museum at St. John, the Archives at Halifax, and the Provincial Museum at Halifax, which last, though congested and disordered, contains much material and might be made into a good museum." By some rearrangement of material, the collections might be made more attractive but the ideal, and, we believe, the final solution must be in the erection of a fireproof museum building comparable to that of the Provincial Archives on the Dalhousie campus or the Saint John City Museum at Saint John, N. B. In most cities the museum has to fill the dual purposes of containing both scientific and historical exhibits. In this Province the situation is unique in that there already exists the splendid Archives building whose entire contents would otherwise have had to be accommodated in the Provincial Museum. This relieves a considerable amount of pressure on the Museum, and it could be, therefore, logically expected that the Provincial Museum should devote most of its space and attention to scientific exhibits without altogether neglecting such historical exhibits as cannot be housed in the Provincial Archives. A building suitable for the needs of the Province should contain rooms for special exhibits, accommodations for the safe care and preservation under glass of the systematic collections, small laboratories for the study and identification of specimens, a lecture hall and suitable offices for the staff and visiting scientists. It should contain large storage space because only a fraction of the contents can be effectively displayed at one time. There should be ample accommodations for reading room and stacks for the Provincial Science Library. The Science Library should be an essential part of any museum, and we are very fortunate in possessing in the present library a collection which in some respects is unequalled in Canada. These facilities would establish the Museum as the scientific center of the Province.

4. *The Relation between the Provincial Museum and the Institute of Science.*

The Institute of Science takes special pride and interest in the Museum, which is its offspring. Both organizations have a common scientific interest and are closely connected through long years of intimate association. Needless to say the Institute is prepared to cooperate with the Museum to the fullest extent. If the Museum had a suitable lecture hall, it would be the natural place for the

> meetings of the Institute. Public lectures and exhibitions by the Institute might well be a part of the Museum's functions. A great proportion of the accessions to the Provincial Science Library come through the Institute. The Proceedings of the Institute is the natural place for publishing the scientific observations and discoveries made by the staff of the Museum or by scientists attracted by the collections and facilities of the Museum. Through a proper organization of the Museum's activities, its relationship with the Institute should be strengthened and the value of both to the Province enhanced.

In 1918 Mr. Matheson assumed the duties of Treasurer of the Institute. How well these duties have been performed, is evidenced by the present excellent state of our treasury. Now Mr. Matheson has asked me to announce that he is not offering for reelection. I am sure that the Institute loses deeply by this decision. The Council, especially, will miss his sound financial sense and canny advice.

Now that I have reached the end of my term of office as your President, I still have a duty, a pleasant one, to perform. I wish to thank you each one, members of the Institute, for the help and inspiration you have given me through these two years. The members of the Council especially have given whole heartedly of their time and thought to the common good. Though the President may not offer a motion, the Council deserves your hearty vote of thanks.

PROCEEDINGS OF MEETINGS

SESSION OF 1940-41

(All meetings were held in the Medical Science Building, Halifax)

79th Annual Business Meeting, October 14, 1940, 8 p.m.

The President, Dr. H. S. King read the annual address. This is printed in full.

The Treasurer's report is summarized as follows:

Receipts	$ 776.81
Expenditures	740.08
Assets	4,999.10

These are made up of (a) balance in Bank of N. S., $1,235.30; (b) balance in Dominion P.O. savings account, $263.80; (c) Maritime Telegraph and Telephone Co. bonds (6% to 1941 and 4½% to 1966), $1,000; (d) Dominion of Canada 4½%, $1,000; (e) Dominion of Canada 4%, $1,000; and (f) Dominion of Canada 3¼% (1st war loan), $500.

Officers elected for the year 1940-1941 were:

President	Professor R. J. Bean
1st Vice-President	Dr. Ernest Hess
2nd Vice-President	Dr. F. R. Hayes
Corresponding Secretary	Dr. D. L. Cooper
Recording Secretary	Dr. C. B. Weld
Treasurer	Professor W. P. Copp
Editor	Dr. Ernest Hess
Librarian	None*
Councillors	Dr. R. D. H. Heard, Dr. M. K. McPhail, Dr. A. E. Cameron, R. A. McKenzie, Esq., Dr. H. S. King.
Auditors	Prof. H. L. Bronson and P. R. Colpitt, Esq.

Nominees to Provincial Science Library Commission—Dr. G. H. Henderson and Dr. Ernest Hess.

---

*Dr. Ernest Hess elected Acting Librarian by Council on November 25, 1940.

Motions of thanks and appreciation to the retiring President and Editor and to the retiring Treasurer were passed unanimously and with applause.

The new President, taking the chair, stressed the need of maintaining good attendance at ordinary meetings and suggested the advisability of occasionally inviting a guest speaker.

1st Ordinary Meeting, November 12, 1940. The following new members were announced (elected by council October 28), Ordinary, D. K. Crowdis, Esq. and A. Hollett, Esq. and Student, W. H. Feindel, Esq. and W. S. Bauld, Esq.

Papers: Some Noteworthy Records of Fish, Salps and a Whale in the Waters Fished by Nova Scotians, by R. A. McKenzie; Steroids IV.—The Isolation from Equine Pregnancy Urine and Characterization of a New Member of the Female Sex Hormone Series, by R. D. H. Heard and M. M. Hoffman; Survival of *Escherichia Coli* and *Eberthella Typhosa* on Salt Fish, by M. Frank and E. Hess; A 35 mm Copying Camera, demonstration by F. R. Hayes.—Refreshments were served.

2nd Ordinary Meeting, December 9, 1940. The following new members were announced (elected by council November 25), Dr. W. J. Dyer, ordinary; Dr. A. J. Wood, ordinary; A. F. McKay, student; and Rev. George Macdonald, associate.

Papers: Steroids V.—The Kishner-Wolff Reduction of Dehydro-iso-androsterone, by R. D. H. Heard and A. F. McKay; Physiological Conditions of Certain Bacteria in Relation to their "Resting Cell" Activity, by A. J. Wood; The Effect of Fluoride on the Permeability of Red Blood Cells, by Hugh Davson.—Refreshments were served.

3rd Ordinary Meeting, January 13, 1941. The election of J. R. F. Warr as associate member was announced (elected by council December 30, 1940).

Papers: A New Barytes Deposit in Nova Scotia, by A. E. Cameron (read by the Secretary in the absence of Dr. Cameron); Phytin as an Organic Constituent of Soil, by

W. J. Dyer; The Synthesis of Substituted Phenanthrenes Related to the Steroids, by W. S. Bauld and C. W. Small.

The following resolution was expressed by Dr. Young and unanimously adopted, "That the members of the Nova Scotian Institute of Science at their meeting on Monday evening, January 13, 1941, wish to express and record their deep regret at the sudden death of Professor Carleton Bell Nickerson which occurred on December 30, 1940. As an enthusiastic member of the Institute of many years standing and as a former president, the Institute feels its loss keenly and will continue so to do for many years to come."—Refreshments were served.

4th Ordinary Meeting, February 10, 1941.

Papers: The Growth of Buds in Wintertime, by H. P. Bell; A Supersonic Oscillator for the Detection of the Upper Limits of Hearing, a demonstration by C. B. Weld; Somatic Chromosomes in *Vicia Faba L.*, by W. H. Feindel.—Refreshments were served.

5th Ordinary Meeting, March 10, 1941.

Papers: Studies on Brown Halophilic Molds of the Genus *Sporendonema* emend. *Redaelli* et *Ciferri*, by M. Frank and E. Hess; Studies on Aqueous Humour, by H. Davson and C. B. Weld; Steroids VI.—Observations on the Constitution of Androstanol-3(β)-one from Equine Pregnancy Urine, by R. D. H. Heard and A. F. McKay; Steroids VII.—The Synthesis of Androstanol-3(β)-one-7, by R. D. H. Heard and A. F. McKay; Kofler's Microscope Hot Stage, a demonstration by R. D. H. Heard.—Refreshments were served.

6th Ordinary Meeting, April 7, 1941.

Papers: Steroids VIII.—The Conversion of Estradiol to Estrone in Man, by R. D. H. Heard and M. M. Hoffman; Pembroke Barytes, by A. E. Cameron; The Estimation of Allantoin in Blood, by Helen Wentworth; The Hatching Mechanism of Salmon Eggs, by F. R. Hayes.—Refreshments were served.

7th Ordinary Meeting, May 5, 1941.

Papers: The Growth Rate of Salmon Embryos, by Florence H. Armstrong; A Dietary Survey in Halifax, by E. Gordon Young.

The latter paper represents work carried out under the auspices of the Canadian Council of Nutrition and notice cards were sent to Public Health authorities, to the Medical and Dental professions, and to Nurse's and Dietitian's organisations.

Extraordinary Meeting, September 26, 1941.

Address: Some Recent Aspects of Genetics, by Prof. R. Ruggles Gates, F.R.S., University of London, King's College (Corresponding Member of the N. S. Institute of Science since 1916). The address is published in full in the Proceedings.

C. B. Weld

Recording Secretary

ABSTRACTS

(Papers read before the Institute but not published in the Proceedings)

STEROIDS IV.—THE ISOLATION FROM EQUINE PREGNANCY URINE AND CHARACTERIZATION OF A NEW MEMBER OF THE FEMALE SEX HORMONE SERIES. R. D. H. Heard and M. M. Hoffman, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read November 12, 1940). From the non-phenolic extract of equine pregnancy urine there has been isolated a new hydroxy ketone which has been definitely characterized as a Δ-5,7,9-estratrienol-3-one-17, a neutral isomer of estrone in which Ring B instead of Ring A is benzenoid.

Analyses of the hydroxy ketone, its acetate, and oxime established the empirical formula $C_{18}H_{22}O_2$, and the function of the two oxygen atoms. The presence of a benzenoid ring in the nucleus was indicated by a positive xanthoproteic reaction and a yellow colour with tetranitromethane, and the absence of isolated double bonds, by saturation to bromine. Proof of the Δ-5,7,9-estratriene skeleton and of the location of the substituents on C_3 and C_{17} was provided by the identification of the product of hydrogenation. (Published in full in J. Biol. Chem., *138*, (2), 651-665, 1941).

SURVIVAL OF *Eberthella Typhosa* AND *Eschvrichia Coli* ON SALT FISH. M. Frank and E. Hess, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read November 12, 1940). The survival of *Eb. typhosa* and *Es. coli* on salt fish agar and in salt fish broth at 5 to 6°C has been shown to extend over periods of three months and more. On salt fish itself, before drying, survival of these organisms is reduced, particularly for the former organism. Survival is favoured by low storage temperature and heavy contamination. (Published in full in J. Fish. Res. Board Can., *5*, (3), 249-252, 1941).

STEROIDS V.—THE KISHNER-WOLFF REDUCTION OF DEHYDRO-ISO-ANDROSTERONE. R. D. H. Heard and A. F. McKay, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read December 9, 1940). For the syntheses of certain isomers of the male sex hormone androsterone, a supply of Δ-5-androstenol-3(β) was required. Reduction of the semicarbazone acetate of Δ-5-androstenol-3(β)-one-17 in sodium ethylate at 180° yielded a complex mixture of 17-desoxy steroids, both saturated and unsaturated, from which the desired product was isolated in the form of a molecular co-ordination compound, m.p. 133°, $[\alpha]_D$-65, consisting (bromine titration) of two moles of Δ-5-androstenol-3(β) and one mole of androstanol-3(β). The sparingly soluble digitonide of the latter was separated from the soluble digitonide of the dibromide of the former, to give, after decomposition, the two components in pure state. Also observed in the course of the reaction were epimerization of the 3-hydroxyl group and reduction of the ethenoid linkage to the 5-cis (aetiocholane) as well as the 5-trans (androstane) saturated nucleus. (Submitted for publication in full to J. Biol. Chem.)

THE PHYSIOLOGICAL CONDITION OF CERTAIN BACTERIA IN RELATION TO THEIR "RESTING CELL" ACTIVITY. A. J. Wood, Cornell University, Ithaca, N. Y., now Atlantic Fisheries Experimental Station, Halifax, N. S. (Read December 9, 1940). The influence of growth conditions on subsequent "resting cell" activity of certain Lancefield Group B Streptococci has been investigated. Their dehydrogenase activity was found to be markedly influenced by the nature of the medium on which the cells were grown. Increasing concentrations of yeast extract in the growth medium, while not materially influencing the total cell crop, produced cells having a much higher dehydrogenase activity per unit of cellular nitrogen. The final hydrogen ion concentration in the growth medium was found to influence activity. If the pH of the medium was permitted to drop to 6.5 or lower the cells recovered from the medium had greatly diminished activity. The significance of these various growth conditions was found to be greater than has been generally recognized. (Submitted for publication in full to J. of Bacteriology).

The Effect of Fluoride on the Permeability of the Red Blood Cell. Hugh Davson, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read December 9, 1940). The permeability of the rabbit erythrocyte to potassium induced by treatment with a NaCl-NaF mixture has been investigated. It has been shown that the effect of fluoride is intimately connected with its poisoning action on glycolysis and the evidence suggests that, as a result of this inhibition, an intermediate product in the chain of chemical reactions which constitute the glycolytic process accumulates in the red cell membrane, and so causes it to become permeable to potassium. (Published in full in J. Cellular and Comparative Physiology, *18*, (2), 1941).

Phytin as an Organic Constituent of Soil. W. J. Dyer, Macdonald College, Que.; now Atlantic Fisheries Experimental Station, Halifax, N. S. (Read January 13, 1941). In the separation of organic phosphorus compounds from soil, it was shown that a material was present which was much more stable than ordinary nucleic acid compounds. A nitrogen free ferric salt was precipitated from a N/6 solution of a soil extract and identified as a phytate, by analysis, reactions, titration with ferric chloride, and behaviour to enzymes. The very insoluble ferric and aluminum phytates were stable to phytase enzyme in acid solution. This is probably the form in which 25 per cent or more of the soil organic phosphorus accumulates in a stable form. (Published in full in Soil Science, *51*, (2), 159-170; (3), 235-248; (4) 323-329, 1941).

The Synthesis of Substituted Phenanthrenes Related to the Steroids. W. S. Bauld and C. W. Small, Dept. of Chemistry, Acadia University, Wolfville, N. S. (Read January 13, 1941). The synthesis of 1-methoxy-2, 13-dimethyl-5,6,7,8,9,10,13,14-octa-hydro-phenanthrene and its conversion to 1-methoxy-2-methyl-phenanthrene by selenium dehydrogenation is described. The starting point of the synthesis was o-cresol, which was nitrated, the hydroxy group methylated, nitro group reduced to amine, converted to iodo derivative by diazotization and treatment with potassium iodide, Grignard formed, treated with ethylene oxide to form β (2-methoxy-3-methyl-phenyl) ethyl alcohol. Primary alcoholic group was then chlorinated, Grignard reagent formed, conjugated with ortho-methyl cyclohexane to form 1- [β-(2-methoxy-3-methyl-phenyl) ethyl]-cyclohexan-1-ol. The ring was then closed by 85% H_2SO_4 to form desired compound, analysis of which was in good agreement with the theoretical. The subsequent dehydrogenation of this compound to 1-methoxy-2-methyl-phenanthrene which was identified from melting point in literature, was in accord with the splitting of the C-10 angular methan group in the selenium dehydrogenation of cholesterol to chrysene, thus confirming steroidal structure as well as providing a route to compounds containing the angular methan group. (Submitted for publication in full to Can. J. Research).

SOMATIC CHROMOSOMES IN *Vicia Faba* L. William H. Feindel, Department of Biology, Acadia University, Wolfville, N. S. (Read January 10, 1941). For a study of chromosome structure, root-tips of *Vicia Faba* L. were fixed in modified Benda's (osmic-chromic-acetic), embedded in celloidin and stained in Haidenhain's haematoxylin. Chromosomes exhibited eight-parted structure at metaphase and quadripartite structure during anaphase, prophase and telophase. Chromomeric appearances as reported by earlier workers are interpreted as tightly coiled or crossed chromonemata.

WINTER GROWTH IN THE VEGETATIVE BUDS OF THE WAGENER APPLE. Hugh P. Bell, Dept. of Biology, Dalhousie University, Halifax, N. S. (Read February 10, 1941). Vegetative buds of the apple were collected from September 26, 1938, to March 18, 1939. The median longitudinal section of each bud was measured. The data collected suggested that a slow but continuous growth in length within the bud proceeds throughout the winter months. The figures were subjected to statistical analysis and found to be significant. (Published in full in Can. J. Research, C, *18*, 585-590, 1940).

STUDIES ON BROWN HALOPHILIC MOLDS OF THE GENUS *Sporendonema* emend. CIFERRI ET REDAELLI. M. Frank and E. Hess, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read March 10, 1941). Twenty-six cultures of brown halophilic molds, isolated from undried and dried salt fish, air, salt, floor dust and date fruits, were studied. Halophilism, temperature and pH limits for growth, and ability to liquify gelatine and utilize various sugars were compared. Nineteen cultures, including all salt fish isolations, belong to the species *Sporendonema epizoum* (Corda) Ciferri et Redaelli. They are true halophiles, do not grow at 37°C, and do not liquify gelatine; spores are large, and medium to dark brown over the whole temperature range at medium salt concentrations. The other strains are facultative halophilic, grow at 37°C, liquify gelatine, have small spores of light brown colour, and resemble *Torula minuta* Hφye i.e. *Sporendonema minutum* (Hφye) n.comb. (Published in full in J. Fish. Res. Board Can., *5*, (3).287-292, 1941).

STUDIES ON AQUEOUS HUMOUR. H. Davson and C. B. Weld, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read March 10, 1941). Hodgson (J. Physiol. 1938, 94, 118) has shown that the serum/aqueous chloride in dogs is 0.92. The theoretical ratio on the basis on Donnan equilibrium calculations is 0.96. This excess of chloride is used as evidence that aqueous humour is not a simple dialysate of blood plasma.

We have confirmed Hodgson's finding, obtaining a ratio of 0.922 (standard error of mean .005). Reformed aqueous humour, taken shortly after the original paracentesis, gives a lower chloride and a serum/aqueous ratio approximately unity. Within 5-6 hours the ratio is back to the 0.92 level however. If the lens is removed, the ratio is slightly lowered for a time but after 2-3 months, when the inflammatory process is over and the eye completely healed, the chloride in the aphakic aqueous is at its original level and the serum/aqueous ratio again 0.92.

The serum/aqueous ratio with respect to CO_2 has also been determined and found to be 0.84. The standard deviation is 0.05.

The serum/aqueous ratio of the cation sodium is found to be 1.042 (SD .001). This corresponds closely to the theoretical figure of 1.04. In view of this finding it cannot yet be claimed that the apparent excess of chloride in the aqueous humour has any osmotic significance. (Published in full in Am. J. Physiol., *134*, (1), 1-7, 1941).

Steroids VI.—Observations on the Constitution of Androstanol-3(β)-one From Equine Pregnancy Urine. R. D. H. Heard and A. F. McKay, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read March 10, 1941). Previously the authors reported the isolation of an isomer of androsterone which differed from the latter in the orientation of the C_3-OH and the position of the ketonic oxygen atom. Present investigations, concerned with the location of the carbonyl group, surprisingly indicate a 15-keto derivative. Positions 1, 2, 4, and 17 were eliminated by reason of the non-identity of the corresponding diketone with androstanedione-3,17 and its failure to show reactions characteristic of an α or β diketone. The ease of oximation of the urinary androstanol-3(β)-one, and its high levorotation ($[\alpha]_D$-160°), argue against C_{11} or C_{12}, and the negative response in the Liebermann-Burchard test contrasts with the behavior of saturated 6-ketosteroids. The 7-keto compound seemed likely, but, on synthesis, it proved non-identical with the natural. Remaining are positions 15 and 16; a 16-keto derivative, containing the—CH_2-CO-CH_2—linkage, is improbable because of the feeble color developed by the urinary hydroxy ketone with m-dinitrobenzene. (Submitted for publication in full to J. Biol. Chem.).

Steroids VII.—The Synthesis of Androstanol-3(β)-one-7. R. D. H. Heard and A. F. McKay, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read March 10, 1941). The preparation of androstanol-3(β)-one-7 (m.p. 131°, $[\alpha]_D$-69°) proceeded from the semicarbazone acetate of dehydroiso-androsterone. Reduction (Wolff-Kishner) yielded mainly △-5-androstenol-3(β) (m.p. 137°) and androstanol-3(β) m.p. 148)°. Oxidation of △-5-androstenol-3(β) acetate (m.p. 94°) with warm chromic anhydride gave the acetate of △-5-androstenol-3(β)-one-7 (m.p. 174°; λ_{MAX}234mμ; ϵ_{MAX} 11,200) which, on hydrogenation and oxidation, was converted to androstanol-3(β)-one-7 acetate (m.p. 110-113°). (Submitted for publication in full to J. Biol. Chem.).

Steroids VIII.—The Conversion of Estradiol to Estrone in Man. R. D. H. Heard and M. M. Hoffman, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read April 7, 1941). To substantiate the generally accepted hypothesis that the urinary estrogens, estrone and estriol, arise from the follicular hormone, α-estradiol, the fate in man of injected α-estradiol was investigated. 300 mg. were administered intramuscularly in oil throughout 8 days. The urine (18.7 liters) collected during the administration period and the succeeding fortnight was subjected to hydrolytic treatment (2 hours in the autoclave at 15 pounds, with 40 ml. of concentrated hydrochloric acid per liter) and extracted with benzene. The benzene-soluble material was washed free of acids and divided into a phenolic (890 mg.) and a neutral (957 mg.) fraction. Separation of the ketonic phenols with Girard's Reagent P yielded 40.4 mg. of a mixture of crystals and oil, which, on crystallization from ether, gave estrone melting at 248-253° (Kofler's micromethod; corrected) and at 252-256° on admisture with an authentic specimen (m.p. 256-259°). From the non-ketonic phenols (113 mg.), 9.8 mg. of unchanged α-estradiol were recovered. The neutral fraction was carefully examined for products of complete saturation of the estrane nucleus, i.e. the estranediols; only dehydro-iso-androsterone, androsterone aetiocholanol-3(β)-one-17, pregnanediol-3(α), 20(α), and cholesterol were encountered. (Published in full in J. Biol. Chem., *140*, 1941, in press).

THE ESTIMATION OF ALLANTOIN IN BLOOD. Helen Wentworth, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read April 7, 1941). A method for the estimation of allantoin in blood based on the Rimini-Schryver reaction is described. 5cc. of mammalian blood are required for an estimation. This method permits of an accuracy of about ±10 per cent using the ordinary Duboscq colorimeter.

THE HATCHING MECHANISM OF SALMON EGGS. F. R. Hayes, Dept. of Biology, Dalhousie University, Halifax, N. S. (Read April 7, 1941). The changes in the force required to break an egg as development proceeds are described and the time of appearance of the hatching enzyme in the perivitelline fluid determined. It is found that the egg shell softens before the hatching enzyme appears. The enzyme acts best in a slightly alkaline medium. (Submitted for publication in full to J. Cellular and Comparative Physiology).

THE GROWTH RATE OF SALMON EMBRYOS. Florence H. Armstrong, Dept. of Biology, Dalhousie University, Halifax, N. S. (Read May 5, 1941). Embryos were weighed periodically during the first winter of development. When the logarithm of the weight is plotted against age, a series of straight lines is obtained, the slopes of which decrease with advancing age. In other words the growth rate is constant for a certain period and then changes abruptly to another rate which in its turn remains constant for a time. In the total time under consideration there are three such periods. During the latter part of development the growth rate of grilse eggs, which are smaller than salmon, was measured. The embryos were found to grow more rapidly than those of salmon and thereby tended to catch up to them in size. (Submitted for publication in full to Can. J. Research).

A DIETARY SURVEY IN HALIFAX. E. Gordon Young, Department of Biochemistry, Dalhousie University, Halifax, N. S. (Read May 5, 1941). A dietary survey comprising 82 families and 385 individuals has been carried out in Halifax by both inventory and individual methods in the income range of $450-$1500 per annum. The results in terms of nutritional essentials have been compared with the Canadian Dietary Standard. The most important findings were a deplorable deficiency in the intake of calcium by the children and of the vitamins, especially B_1 by the whole group. (Published in full in Can. J. Publ. Health, *32*, 236-240, 1941).

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

VOL. XX. 1941-1942 PART 4

Museum of Compar. Zoolog.
JAN 25 1943
LIBRARY

CONTENTS

Additions to the List of Odonata of the Maritime Provinces. E. M. Walker 159
The Grasses of Nova Scotia. W. G. Dore and A. E. Roland 177
Presidential Address. R. J. Bean 289
Proceedings of Meetings. Session of 1941-42 293
Abstracts. (Papers read before the Institute but not published in the Proceedings) 297
Index to Vol. XX 302

Editor: Ernest Hess
Editorial Board: H. L. Bronson, R. D. H. Heard and Dixie Pelluet
Printed for the Institute by The Imperial Publishing Company Limited
Date of Publication: December 30, 1942

PROCEEDINGS
OF THE
Nova Scotian Institute of Science

SESSION OF 1941-42
(Vol. XX, Part 4)

6253
JAN 25 1943
LIBRARY

ADDITIONS TO THE LIST OF ODONATA OF THE MARITIME PROVINCES

E. M. Walker
Department of Zoology, University of Toronto

(Received April 13, 1942)

ABSTRACT

Ten species of Odonata are added to the number hitherto known from the Maritime Provinces, nineteen to the Nova Scotia list and five to the New Brunswick list. No new records have been received from Prince Edward Island. The totals now stand as follows: Nova Scotia, 76 species; New Brunswick, 67; Prince Edward Island, 15; total for the Maritime Provinces, 88 species.

Since the publication of the writer's list of the Odonata of the Maritime Provinces of Canada (Walker, 1933) many records have been gathered, which add materially to our knowledge of the fauna of this region. The collections on which most of these records are based may be listed under the names of the collectors and localities as follows:

C. E. Atwood: Nashwaaksis River, Longo Creek and Fredericton, N. B. (National Collection, Ottawa, and Royal Ontario Museum of Zoology, Toronto).

W. J. Brown: Annapolis Royal, N. S.; Boiestown and Fredericton, N. B. (National Collection, Ottawa).

J. H. McDunnough: South Milford, Annapolis Co., N. S., and White Point Beach, Queen's Co., N. S. (National Collection, Ottawa).

E. M. Walker: Clementsport, Milford and other localities in Annapolis and Digby Cos., N. S. (Royal Ontario Museum of Zoology, Toronto).

H. C. White: Moser River, Halifax Co., N. S.

The writer collected in 1940 from July 5 to 20 and again in 1941 during the first half of August.

In the following list ten species are added to the number hitherto known from the Maritime Provinces, nineteen to the Nova Scotia list and five to the New Brunswick list. No new records have been received from Prince Edward Island. The totals now stand as follows: Nova Scotia, 76 species; New Brunswick, 67; Prince Edward Island, 15; total for the Maritimes, 88.

ZYGOPTERA

AGRIIDAE

Agrion maculatum Beauv.

N. S., Annapolis Co.—Annapolis Royal, 24 VII '28 (W.J.B.), outlet of Baillie Lake, 5 to 15 VII '40, abundant; 10 VIII '41, fairly common; Lequille River near Lamb Lake, 12 VII '40; small stream near Lake La Rose, 17 VII '40, abundant; 8 VIII '41, 2♂; Milford, 9 VII '40, one or two at outlet of bog lake (E.M.W.).

Males were displaying their courtship flight along the small stream near Lake La Rose on July 17, 1940, and near the head of the small rapid stream which flows out of Baillie Lake, on Aug. 11, 1941. On the former date a newly emerged adult with its exuvia was found, and on the latter date a male was seen to hover before a female which was resting on foliage overhanging the water. He faced the female within a few inches, with the four wings spread apart like a cross and vibrating rapidly. After hovering thus for about half a minute he seized the prothorax of the female with his anal appendages. The female remained on the leaf, the abdomen bending downward, but another half minute or so was passed before she finally bent the abdomen forward to engage the genitalia of the male.

Agrion aequabile Say.

N. B.—Fredericton, 2 VII '28 (W.J.B.); Nashwaaksis River, 8 VII '34 (C.E.A.).

Throughout the Maritime Provinces this species is slightly smaller, in average size, than in southern Ontario, and the dark areas at the apices of the wings are more nearly equal, those of the front wings being larger and those of the hind wings slightly smaller.

Agrion amatum (Hagen).

N. B.—Longo Creek, 10 VII '34, 1♂ 1♀; Phyllis Creek near Fredericton, 24 VI '34, 1♀ (C.E.A.).

LESTIDAE

Lestes congener Hagen.

N. S., Annapolis Co.—Clementsport, 3 VIII '41, 1♂; 15 VIII '41, 1♀ (E.M.W.).

The male had just emerged from a small pond, formed by damming the outlet of a springy bog on a partially wooded slope, above the village. The female was found within a few minutes' walk from the same pond and was also a teneral. The season was doubtless just beginning, as this is a late species. The records are the first for Nova Scotia.

The pond referred to is the same one at which the next five species were taken and where *Aeschna verticalis* Say was found emerging in 1940. It was nearly covered by a somewhat dense stand of sedges. The principal area of open water, which was only a few square yards in extent was just above the dam. As the writer discovered this pond through the croaking of innumerable green frogs, and a few swamp tree frogs and spring peepers, it will be referred to for convenience as the "frog pond."

Lestes unguiculatus Hagen.

N. S.—Clementsport, 20 VII '40, many tenerals; 1 to 7 VIII '41, abundant (E.M.W.).

These were all taken at the frog pond referred to above. Their season was just beginning at the end of my visit in 1940 but they were mature in August, 1941, some pairs in copula having been observed. They showed a distinct tendency to frequent the edges of the open water, just above the dam, and adjacent areas where the emergent vegetation was very short. This is usually a species of temporary ponds.

Lestes dryas Kirby (syn. *L. uncatus* Kirby).

N. S.—Clementsport, 5 to 20 VII '40; 1 to 3 VIII '41 (E.M.W.).

This species was already mature on July 5, 1940, when no other species of *Lestes* had yet appeared at the frog pond. It was still present in August, 1941, at the same pond but was not abundant at any time. It is typically a species of temporary ponds and was somewhat out of its usual habitat at the frog pond.

Lestes disjunctus Selys.

N. S., Annapolis Co.—Clementsport, 1 to 7 VIII '41; outlet of Baillie Lake, 11 VIII '41, 1♂; Digby Co.—pond near Digby, 7 VIII '40, common (E.M.W.).

Males were common among the tall sedges growing in the frog pond, most of them mature. Females appeared around the edges of the pond or in the bushes along the shore and were scarce, most of them still rather juvenile. Pairs in copula were observed on Aug. 7. This species is typical of permanent waters.

Lestes forcipatus Rambur.

N. S., Annapolis Co.—Clementsport, 1 to 7 VIII '41; pond near Lequille, 12 VII '40; cold marshy lake near Graywood, 12 VII '40 (E.M.W.).

The specimens taken in July were all tenerals, those in August mature. It was abundant at the shallow pond near Lequille and also at the frog pond, where its numbers about equalled those of *L. unguiculatus.* It frequented the tall sedges rather than the open water and nearly all the individuals seen were males, except in the case of copulating pairs, which were common on Aug. 7. These are the first records for Nova Scotia.

Lestes rectangularis Say.

N. S., Annapolis Co.—Clementsport, 3 to 15 VIII '41; outlet of Baillie Lake, 15 VII '40, 1♂; 11 VIII '41, a few ♂'s; Lamb Lake 4 VIII '41 2♂; Milford, 5 VII '40, 2♂, 5 VIII '41, a few ♂'s seen. Digby Co.—pond near Digby, 19 VII '40 (E.M.W.).

Only one male was seen at the frog pond on Aug. 3 but it was becoming commoner by Aug. 15. It was the only *Lestes* seen at the bog lake where *L. vigilax* was taken in July, 1940.

Lestes vigilax Hagen.

N. S., Annapolis Co.—Milford, 8, 9 VII '40; cold marshy lake near Graywood, 12 VII '40, 1♀ (E.M.W.).

This species was found along the moat or open ditch at the foot of a rocky wooded slope, bordering a large floating sphagnum bog. All the individuals seen were more or less teneral. On visiting the same spot on Aug. 5, 1941, the ditch was dried up and *L. vigilax* had disappeared.

This is the first record of this species for the Maritimes.

COENAGRIIDAE

Argia moesta (Hagen).

N. S., Annapolis Co.—Sandy Bottom Lake, 5 VII '40, abundant; Beeler Lake, 20 VII '40, 1♀; Lequille River below Lamb Lake, 4 VIII '41 (E.M.W.); South Milford, 26 VI '34 (J.H.M.).

It was most abundant at Sandy Bottom Lake, where most of the population were young adults, some just emerged. Old males were fairly common on the Lequille River on August 4.

These are the first records from Nova Scotia.

Argia violacea (Hagen).

N. S., Annapolis Co.—Baillie Lake, 5 VII '40, common; outlet of Baillie Lake, 15 VII '40, 11 VIII '41; stream near Lake La Rose, 17 VIII '40, 18 VIII '41; near Fisher's Lake, 16 VII '40; near Beeler Lake, 20 VII '40 (E.M.W.).

Common along small streams with exposed rocks. On July 5 only tenerals were seen but on and after July 11 fully coloured individuals were the rule. They were still common in August, 1941.

Enallagma boreale Selys.

N. S., Annapolis Co.—Reservoir Lake on "North Mt." near Bridgetown, 6 VII '40, frequent, some pairs in copula (E.M.W.).

N. B.—Near St. George, 16 VII '34, 1♂ (C.E.A.).

Except on the higher land on the Fundy side of the Annapolis Basin, the season for this early species was doubtless over before collecting was begun in 1940. Although common across the continent it had not been previously reported from Nova Scotia.

Enallagma hageni (Walsh).

N. S., Annapolis Co.—outlet of Baillie Lake, 5, 15 VII '40, common along the quieter reaches, 11 VIII '41, scarce; small lake near Graywood, 8 VII '40, frequent; Beeler Lake, 20 VII '40; Lamb Lake, 12, VII '40 (E.M.W.); Milford, 1 VII '34 (J.H.M.); 5 VIII '41, 1♂ at bog pond (E.M.W.). Halifax Co., Moser River, 18 VIII '40, 2♂ 1♀ (H.C.W.).

N. B.—Nashwaaksis River, 1 mile from mouth, 23 VI '34, 4♂ 4♀ (C.E.A.).

The season for this abundant species was apparently already waning in early July, 1940, and was practically over in August, 1941. June is the month of its great abundance.

Enallagma ebrium (Hagen).

N. S., Annapolis Co.—small lake near Graywood, 8 VII '40, fairly common. Digby Co.—Midway Lake, 14 VII '40, common (E.M.W.).

Enallagma minusculum Morse.

N. S., Annapolis Co.—near Beeler Lake, 20 VII '40, 1♂; Fisher's Lake, 16 VII '40, 1♂, flying over water near shore (E.M.W.).

The scarcity of this species suggests that the season was nearly over.

Enallagma carunculatum Morse.

N. S., Annapolis Co.—Fisher's Lake, 16 VII '40, 1♂, flying over water near shore (E.M.W.).

N. B.—Bocabec Lake, 19 VII '23, 1♂ (E.M.W.).

The male from Bocabec Lake was taken with *E. civile* and was overlooked in my previous paper. It has not been hitherto reported from the Maritime Provinces.

Enallagma civile (Hagen).

N. S., Annapolis Co.—Beeler Lake, 20 VII '40, 2♂, recently emerged; Lake La Rose, 20 VII '40, many tenerals; Cady Lake, 11 VIII '41, 6♂'s, (E.M.W.). Queen's Co.—White Point Beach, 11, 12, 19 VII '34 (J.H.M.).

The distribution of this species in Canada appears to be discontinuous. It is common in the Maritime Provinces unknown in Quebec, rare in Ontario, except in the extreme west, and abundant in southern Manitoba, decreasing in numbers again westward and apparently not reaching British Columbia.

Enallagma vesperum Calvert.

N. S., Annapolis Co.—small lake near Fisher's Lake, 16 VII '40, 1♂; Beeler Lake, 20 VII '40, 1♂ 2♀ (E.M.W.).

These specimens differ from Ontario examples in the greater width of the dark humeral band. It was not previously known from Nova Scotia.

Ischnura verticalis (Say).

N. S., Annapolis Co.—Clementsport, 5 to 8 VII '40, 1 to 3 VIII '41; Baillie Lake, outlet, 15 VII '40, 11 VIII '41; Cady Lake, 5 VII '40, 11 VIII '41; Beeler Lake, 20 VII '40; Lamb Lake, outlet, 4 VIII '41; small stream near Lake La Rose, 17 VII '40, 8 VIII '41; small lakes in vicinity of Fisher's Lake, 16 VII '40; Milford, 8, 9, VII '40; 5 VIII '41 (E.M.W.), 23 VI '34 (J.H.M.). Digby Co.—pond near Digby, 7 VIII '41; Midway Lake, 14 VII '40 (E.M.W.); Queen's Co.—White Point Beach, 12 VII '34 (J.H.M.).

N. B.—Nashwaaksis River, 23 VI '34, 2♂ 2♀ (C.E.A.)

This was much the most generally distributed damselfly and usually the most abundant. On the small streams, such as the outlet of Baillie Lake and the brook near Lake La Rose, it was restricted to the quiet reaches.

Ischnura posita (Hagen).

N. S., Annapolis Co.—Milford, ditch bordering open bay, 8, 9 VII '40; outlet of Baillie Lake, 15 VII '40; stream near Lake La Rose, 17 VII '40, 8 VIII '41 (E.M.W.).

On the streams this little damselfly was commoner than *I. verticalis* where there was a slight current but less common than that species on the quiet reaches.

Nehalennia irene (Hagen).

N. S., Annapolis Co.—Clementsport, 1, 3 VIII '41, common at the frog pond among the short sedges, bordering open water; outlet of Baillie Lake, 15 VII '40, frequent on quiet reaches; Milford, 8, 9 VII '40, common in the open bog (E.M.W.).

This species had disappeared from the Milford bog in August, 1941.

Nehalennia gracilis Morse.

N. S., Annapolis Co.—Milford, open bog, 8 VII '40, 1♂ (E.M.W.); Queen's Co.—White Point Beach, 21 VII '34, 4♂ 1♀ (J.H.M.).

These are the first Nova Scotia records.

Chromagrion conditum (Hagen).

N. S., Annapolis Co.—outlet of Baillie Lake, 15 VII '40, occasional along the brook, chiefly in a boggy pasture (E.M.W.); Milford, 21 VI '34, 2♂ 4♀ (J.H.M.).

These are the first Nova Scotia records.

ANISOPTERA

Aeschnidae

Gomphaeschna furcillata (Say).

N. S., Annapolis Co.—Milford, 27 to 30 VI '34 (J.H.M.); 8, 9 VII '40 (E.M.W.).

A good series of males was taken along a road at South Milford by Dr. McDunnough. The writer first saw this species in the afternoon of July 8, flying along the ditch which borders an extensive open sphagnum bog, at the foot of a rocky wooded slope. The ditch was full of water about a foot deep and was overhung by the branches of small maritime birches, alders and other trees. Occasional individuals flew along the ditch but none appeared over the open bog. Two were taken, both males. The same bog was visited on the following morning, the weather being fine and warm. On this occasion *Gomphaeschna* was flying over the open bog as well as the ditch and a series of eight males was taken. They were easier to net on the wing than most aeschnids. No females nor exuviae could be found. The bog was visited a third time on July 16. The weather was fair but windy and not a single *Gomphaeschna* was seen.

These are the only Canadian records for this species.

Boyeria vinosa (Say).

N. S., Halifax Co.—Moser River, 13 VIII '40, 1♂; 1 X '40, 1♂ (H.C.W.).

Boyeria grafiana Wmsn.

N. S., Halifax Co.—Smith Brook, Moser River, 20 VII '40, 1♀, somewhat teneral (H.C.W.); 3 IX '40, 1♂ 1♀ (D. G. Wilder).

These are the first records of this species for the Maritime Provinces.

Basiaeschna janata (Say).

N. S., Annapolis Co.—Baillie Lake, 5, 15 VII '40, 1♂ at outlet; others seen along the stream where it flows through an open marsh; Lequille River, below Lamb Lake, 12 VII '40, not infrequent over both quiet and rapid parts of the stream; stream near Lake La Rose, 17 VII '40, a few patrolling the stream; Milford, outlet of bog lake, 9 VII '40 (E.M.W.).

N. B.—Nashwaaksis River, 23, 27 VI '34, 1♀ (C.E.A.).

Aeschna clepsydra Say.

N. S., Halifax Co.—Moser River, 21, 25 VIII '40, 2♂ (H.C.W.).

Aeschna canadensis Walker.

N. S., Annapolis Co.—Clementsport, 7 VIII '41; outlet of Baillie Lake, 11 VIII '41; Milford, 5 VIII '41 (E.M.W.), 28 VI '34 (J.H.M.). Digby Co.—pond near Digby, 7 VIII '41 (E.M.W.).

This species was abundant at the "frog pond," where *A. verticalis* emerged in numbers in 1940. It was also common at the other stations, and was the only aeschnid at the Milford bog pond, where *Gomphaeschna furcillata* was taken in 1940. August is, of course, too late for the latter species.

Aeschna verticalis Say.

N. S., Annapolis Co.—Clementsport, 5 to 20 VII '40, many newly emerged adults with exuviae; 1 VIII '41, 1♀ (E.M.W.).

On July 5 a male and a female, just emerged, with exuviae, were found at the "frog pond." The pond was visited daily for the next three days and each day several newly emerged specimens were found, as well as a large number of exuviae. A final visit was made to the pond on July 20 and a few more exuviae were taken but no more adults. The season of emergence appeared to be about over. Altogether nearly forty exuviae were collected. On visiting the same pond in August, 1941 the first *Aeschna* taken was *verticalis* and the only exuvia found was also this species. Aeschnas were plentiful but nearly all were *canadensis*.

This is the first time that *A. verticalis* has been found in emergence. The nymph has been recently described by the writer (Walker, 1941). This species was hitherto unknown from Nova Scotia.

Aeschna tuberculifera Walker.

N. S., Annapolis Co.—Clementsport, 7 VIII '41, 1♂ (E.M.W.). Hants Co.—Falmouth, 26 VIII '37, 1♀ (H. E. Payne). Colchester Co.—Truro, 12 IX '37, 1♀ (M. D. Payne). Lunenburg Co.—Petite Riviere Bridge, 9 VIII '36, 1♀, 13 VIII '36, 1♂ (T. N. Freeman).

The male from Clementsport was taken at the frog pond among many specimens of *A. canadensis*. The species is new to the Maritime Provinces but is evidently commoner here than in Ontario or Quebec.

Aeschna umbrosa Walker.

N. S., Halifax Co.—Halfway Brook, Sheet Harbour, 13 IX '40, 2♂; Goldmine Brook, Moser River, 21, 22 VIII '40, 2♂ 1♀ (H.C.W.).

N. B.—Fredericton, 7 VIII '35, 1♀ (J. C. R. Burnham).

Anax junius Drury.

N. S., Annapolis Co.—Clementsport, 5 VII '40, one seen at the frog pond.

GOMPHIDAE

Hagenius brevistylus Selys.

N. S., Annapolis Co.—near Baillie Lake, 9 VII '40, 1♂ (E.M.W.). Halifax Co.—Moser River, 10 to 21 VIII '40, 1♂ 2♀ (H.C.W.).

Mr. White reports this species to be common on the Moser River.

Ophiogomphus carolus Needham.

N. S., Halifax Co.—Moser River, 12 VI '40, 1♀ (H.C.W.).

N. B.—Longo Creek, 10 VII '34, 1♀ (C.E.A.).

Ophiogomphus rupinsulensis (Walsh).

N. B.—Boiestown, 13 VII '28, 4♂ 1♀ (W.J.B.).

This is a new record for the Maritime Provinces.

Lanthus albistylus (Hagen).

N. S., Annapolis Co.—stream near Lake La Rose, 17 VII '40, 3♂; 20 VII '40, 1♀ (E.M.W.).

A few males were seen but they were extremely wary. They rested frequently on boulders in shallow running water.

Gomphus exilis Selys.

N. S., Annapolis Co.—Baillie Lake and outlet, 5, 15 VII '40, occasional; Cady Lake, 5 VII 40, 1♂, others seen; Reservoir Lake, near Bridgetown, 6 VII '40, 1♂; Lequille River, just below Lamb Lake, 12 VII '40, ♀ ovipositing; vicinity of Fisher's Lake, 16 VII '40, 1♂ (E.M.W.).

The season for this common species was evidently past its height.

Gomphus brevis Hagen.

N. S., Halifax Co.—Bear Lake, Moser River, 12 VI '40, 2♀, 16 VI '40, 3♂ (H.C.W.).

Gomphus ventricosus Walsh.

N. B.—Fredericton, 30 VI '34, 1♂ (C.E.A.).

This is the first record for the Maritime Provinces and was unexpected.

CORDULEGASTERIDAE

Cordulegaster maculatus Selys.

N. S., Annapolis Co.—Moose River near Clementsport, 9 VII '40, 1♂, others seen; stream on Lequille Rapid near Lake La Rose, 17 VII '40, 2♂'s, others seen including an ovipositing female (E.M.W.).

N. B.—Longo Creek, 10 VI '34, 1♂ (C.E.A.).

Cordulegaster diastatops Selys.

N. S., Halifax Co.—Moser River, 4 VII '42, 1♂ (H.C.W.).

N. B.—Longo Creek, 10 VI '34, 1♂ (C.E.A).

CORDULIIDAE

Dorocordulia lepida (Hagen).

N. S., Annapolis Co.—outlet of Baillie Lake, 15 VII '40, 1♂; Lamb Lake, 12 VII '40, 1♀ (E.M.W.); S. Milford, 23 VI '34, 7 VII '34, 4♂ 4♀ (J.H.M.).

The male from Baillie Lake was found clinging to herbage near the ground, close to a rapid part of the stream. The female from Lamb Lake was ovipositing under bushes along a marshy bit of the shore.

Dorocordulia libera (Selys).

N. S., Annapolis Co.—Milford, 8 VII '40, 2♂'s flying around the edge of one of the ponds in the floating bog (E.M.W.).

Somatochlora minor Calvert.

N. S. Annapolis Co.—S. Milford, 6 VI '34, 1♂, 26 VI '34 1♀ (J.H.M.).

Two individuals of a Somatochlora that appeared to be this species were seen hovering over the outlet of Baillie Lake on Aug. 11, 1941, but both escaped.

Somatochlora elongata (Scudder).

N. S., Annapolis Co.—S. Milford, 26 VI '34, 1♀ (J.H.M.); small stream on the Lequille Road near Lake La Rose, 17 VII '40, 2♂'s, others seen (E.M.W.). Halifax Co.—Halfpenny Brook, Sheet Harbour, 28 VIII '40, 1♂; Moser River, 1 IX '40, 1♀ (H.C.W.).

N. B.—Boiestown, 11 VII '28, 1♂ (W.J.B.).

Somatochlora kennedyi Walker.

N. B.—Fredericton, 17, 30 VI '34, 2♀; 12 VII '30, 1♀; St. John River near Jennsey, 3 VII '35, 2♂; near Yaho, 7 VI '34, 1♂ (C.E.A.).

While we did not see this species in Annapolis Co., N. S., in 1940 an exuvia was found at the frog pond on July 5 which appears to belong to it, but might belong to the next species, whose nymph is unknown.

Somatochlora incurvata Walker.

N. S., Queen's Co.—White Point Beach, 19 VII '34, 1♀, 21 VII '34, 1♂ (J.H.M.). Halifax Co.—Moser River 10-15 X '40 1♂ (H.C.W.).

The date of the specimen from the Moser River is by far the latest record we have for any species of Somatochlora in Canada.

Somatochlora cingulata Selys.

N. S., Digby Co.—Midway Lake near Centreville, 14 VII '40, 1♀, recently emerged (E.M.W.).

This specimen was found resting in a dense bed of rushes growing in shallow water near the lake shore. It had apparently flown from the spot from which it had emerged since no exuvia could be found. It is new to the Nova Scotia list.

Williamsonia fletcheri Williamson.

N. B.—Fredericton, 1 VII '31 (R. P. Gorham).

The specimen is in the National Collection. The species is new to the Maritime Provinces.

Helocordulia uhleri (Selys).

N. S., Annapolis Co.—Lequille River below Lamb Lake, 12 VII '40, 1♂, a few others seen (E.M.W.). Halifax Co.—Moser River, 6 VI '40, 1♀ (H.C.W.).

N. B.—Nashwaaksis River, 23-27 VI '34, 3♂ (C.E.A.).

Tetragoneuria canis McLachlan.

N. B.—Nashwaaksis River, 1 mile from mouth, 23 VI '34, 3♂, 8 VII '34, 1♂ (C.E.A.).

Tetragoneuria spinigera Selys.

N. S., Annapolis Co.—S. Milford, 25 VI '34 (J.H.M.); Sandy Bottom Lake, 9 VII '40, 1♂, others seen along road

(E.M.W.). Halifax Co.—Bear Lake, Moser River, 16 VI '40, 1♀ (H.C.W.).

N. B.—Nashwaak, 8 VII '34, 1♂; Oak Bay, 15 VI '34 (C.E.A.).

Tetragoneuria cynosura simulans Muttkowski.

N. B.—French Lake (C.E.A.).

Didymops transversa (Say).

N. B.—Nashwaaksis River, 27 VI '34, 1♂; 8 VII '34, 1♂; near Fredericton, 1 VII '34, 1♂ (C.E.A.).

Macromia illinoiensis Walsh.

N. S., Annapolis Co.—S. Milford, 30 VI '34 (J.H.M.); Lequille River below Lamb Lake, 12 VII '40, ♂ seen; near Fisher's Lake, 16 VII '40, ♂ seen (E.M.W.).

N. B.—Boiestown, 10 VII '28 (W. J. Brown); Canaan River, near Cole's Island, 3 VII 35, 1♀ (C.E.A.).

The individual seen on the Lequille River was patrolling a smooth section of the stream, just below the road bridge. The other, near Fisher's Lake, was flying back and forth over the trees in a red maple swamp, near a small lake.

LIBELLULIDAE

Libellula quadrimaculata L.

N. S., Annapolis Co.—Clementsport, 8 VII '40, one flying over the frog pond (E.M.W.). Halifax Co.—Moser River, 17 VIII '40, 3♂ (H.C.W.).

N. B.—Nashwaaksis River, 8 VII '34, 1♂; Fredericton, 17 VII '34, 1♂ (C.E.A.).

Libellula pulchella Drury.

N. B.—Nashwaaksis River, 8 VII '34, 1♂; Fredericton, 17 VII '34, 1♂ (C.E.A.).

Libellula julia Uhler.

N. S., Annapolis Co.—S. Milford, 21 VI '34 (J.H.M.); bog lake at Milford, 8, 9 VII '40; near Fisher's Lake, 16 VII

'40; Baillie and Cady Lakes, 5 VII '40; Reservoir lake near Bridgetown, 6 VII '40, abundant (E.M.W.).

This species, hitherto unknown from Nova Scotia, was very common along the margin of Baillie Lake, settling on the rocks and the road, and was also common in the open woods skirting the bog lake at Milford.

Libellula exusta Say.

N. S., Annapolis Co.—Lamb Lake, 12 VII '40, 1♀, ovipositing in the Lequille River, just below the road bridge (E.M.W.).

Sympetrum decisum (Hagen).

N. S., Annapolis Co.—Clementsport, frog pond, 5 VII '40, a few just emerged; 6 VII '40, tenerals more numerous; 20 VII '40, very abundant, some adults, including pairs in copula, but mostly tenerals; 1-7 VIII '41, many adults, including pairs, but still emerging; Milford bog pond, 5 VIII '41, common but not abundant; Lequille River, near Lamb Lake, 5 VIII '41; stream near Lake La Rose, 8 VIII '41; pond on Liverpool Road, near Graywood, 12 VII '40, many just emerged; outlet of Baillie Lake, 11 VIII '41, fairly common, pairs in copula. Digby Co.—pond near Digby, 7 VIII '41 (E.M.W.). Halifax Co.—Moser River, 4, 17 VIII '40, 2♂, 30 IX '40, 1♀; Ecum Secum, 11 IX '40, 3♂ (H.C.W.).

N. B.—Nashwaaksis River, 8 VII '34, 1♂; Gagetown, 9 VIII '34, 1♂ 3♀ (C.E.A.).

This appears to be by far the most abundant of Anisoptera in Annapolis County during late summer.

Sympetrum obtrusum (Hagen).

N. S., Annapolis Co.—Clementsport, 20 VII '40, a very few newly emerged individuals among the hosts of *S. decisum* at the frog pond; none seen here in August, 1941; stream near Lake La Rose, 8 VIII '41, 1♀, apparently of this species (E.M.W.).

Sympetrum vicinum (Hagen).

N. S., Annapolis Co.—Milford, 5 VIII '41, a few tenerals fluttering over the bog; outlet of Baillie Lake, 11 VIII '41, tenerals not infrequent about the pond-like expansions of the stream (E.M.W.). Halifax Co.—Moser River, 4, 30 IX '40, 2♂; 2 XI '40, 2♂ (H.C.W.).

N. B.—Gagetown, 9 VIII '34, 1♀ teneral (C.E.A.).

These are the first records of this common species from the Maritime Provinces.

Sympetrum semicinctum (Say).

N. S., Annapolis Co.—outlet of Baillie Lake, 11 VIII '41, several seen, including 2 pairs (E.M.W.). Halifax Co.—Moser River, 24 IX '40, 2♂, 30 IX '40, 1♂ 1♀ (H.C.W.).

One of the pairs observed on the outlet of Baillie Lake was ovipositing in tandem, the female striking the water but not the bank of the stream.

Leucorrhinia hudsonica (Selys).

N. S., Annapolis Co.—Milford, in sphagnum bog, 8 VII '40, 1♂ only; outlet of Baillie Lake, 15 VII '40, not uncommon, flying about the small mossy puddles connected with the larger, pond-like expansion of the stream (E.M.W.).

Leucorrhinia frigida (Hagen).

N. S., Annapolis Co.—Milford, sphagnum bog, 8, 9 VII '40, common; outlet of Baillie Lake, 15 VII '40, frequent about the pond-like expansion of the stream, where pickerel-weed and yellow pond lilies grow (E.M.W.). This is the first record for the Maritime Provinces.

Leucorrhinia intacta Hagen.

N. S., Annapolis Co.—Milford, sphagnum bog, 8, 9 VII '40, frequent about the open water areas, 1 pair in copula; Baillie Lake, 5 VII '40, common about the rocks at the lake margin; outlet of Baillie Lake, 15 VII '40, common about the same pond-like expansions when *L. frigida* was found. Digby Co.—pond near Digby, 9 VII '40, common (E.M.W.).

N. B.—Nashwaaksis River, 1 mile from mouth, 23 VI '34, 1♂; 8 VII '34, 5♂ 1♀ (C.E.A.).

REFERENCES

Walker, E. M. The Odonata of the Maritime Provinces. Proc. N. S. Inst. Sci., **18**:(3):106-128. 1933.

Walker, E. M. The Nymph of *Aeschna verticalis* Hagen. Can. Ent. **73**:229-231. 1941.

THE GRASSES OF NOVA SCOTIA

W. G. Dore
Department of Biology, Dalhousie University
Halifax, N. S.

and

A. E. Roland
Nova Scotia Agricultural College
Truro, N. S.

(Received June 20, 1942)

ABSTRACT

This is a systematic treatment of Gramineae, with keys for identification and notes on characteristics, nomenclature, and distribution of the 121 species of the province. Diagrams illustrating the essential parts of the inflorescence and ligule region, and maps of distribution, are included for most species.

The Grass Family includes a large number of important agricultural and economic plants. In addition to the cultivated cereals, wheat, corn, oats, barley, rye, etc., there are the many valuable forage species making up the herbage of our pastures and the hay of seeded or natural meadowlands. Grasses also form the turf of lawns, greens, and landing fields, surviving where most other types of plants would soon be eliminated by the repeated cutting and treading. Certain firmly-rooted and sod-forming species are useful in preventing the erosion of soil and the drifting of sand; others aid in causing the deposition of water-borne and tidal silts and in building up and holding the extensive marshes for which the province is noted. A few have become serious weeds in fields, waste-places and gardens. Many species of woodlands, swamps, and waysides offer food for wild life.

Botanically, the grasses are among the most difficult of all the flowering plants to classify. This is due, in large part, to their great variety and the relatively small size of the reproductive parts. Although much study has been given to the grasses of this continent, particularly during the past thirty years, considerable confusion still exists in the literature as to their classification. The following account is an attempt to bring together and summarize the known information on the various species to be found within the borders of Nova Scotia, and to present keys, descriptions, and diagrams of the essential parts that may aid in their identification. The notes and maps of the distribution within the province are based on specimens in herbaria, published records, and field observations of the authors.

The first list that we have for the province is contained in Titus Smith's manuscript, dated 1801-02, in the Provincial Archives. Twelve species are listed, some of which are not recognizable from the names given. Dr. George Lawson and Dr. A. W. H. Lindsay of Halifax collected many grasses among other plants and their records are embodied in Lindsay's list, sometimes referred to as Sommer's Catalogue, which appeared in the Proceedings of this Institute in 1876. This list gave 23 species of grasses, a few of which have since been revised or deleted.

Since the publication of Lindsay's catalogue, many more sections of the province have been visited by professional botanists, and the whole group of grasses is better understood from a systematic standpoint. A number of species have been introduced in the intervening years and have become naturalized to our flora. The present list, including all the forms that have been available to the authors as preserved specimens or recorded in the literature up to 1942, includes 121 species, 32 additional varieties, and 18 forms. The increase in the knowledge of our grass flora has been due to a large extent to the exploration of John Macoun in various parts of the province in 1883, in Cape Breton in 1898, on Sable Island in 1890, and again on the mainland in 1910. The Gray Herbarium Expedition of Harvard University in the summers of 1920 and 1921, under the direction of Professor M. L. Fernald, covered most of the southern and western portions of the province.

Fernald's reports (1921, 1922) have been most valuable in contributing to the records of new species and distribution of grasses. The survey of Sable Island by Harold St. John in 1913 and of St. Paul Island by L. M. Perry and M. V. Roscoe in 1929 have contributed lists of plants, including grasses, from these outlying points. In later years, smaller collections have been made by H. Groh, A. R. Prince, C. E. Atwood, M. O. Malte, H. T. Güssow, J. Adams, J. W. McLellan, J. Rousseau, and others. The authors have done most of their collecting since 1936. During the past two years, M. S. Brown and L. Brown of Halifax have contributed many specimens.

Specimens preserved in the following herbaria have been examined: National Museum of Canada, Ottawa; Division of Botany, Department of Agriculture, Ottawa; Dalhousie University, Halifax; Nova Scotia Agricultural College, Truro; Acadia University, Wolfville; Provincial Museum, Halifax; and the Dominion Experimental Station, Kentville. In all, about 1800 specimens have been seen. Collections of the authors, constituting about half this number, are deposited in the Herbarium of the Division of Botany at Ottawa, and the Herbarium of the Nova Scotia Agricultural College at Truro. Duplicates have been distributed to various other institutions.

In the subdivision of Gramineae into the various tribes and genera, and in the sequence of these, Hitchcock's Manual (1935) has been followed. Characters used in the descriptions and keys, however, apply only to material as represented in Nova Scotia. Measurements of lemmas, when not otherwise stated, refer to the lowest floret of the spikelet. The lemmas of the upper florets are generally shorter. Leaves from the vegetative shoots or from the base of the culm were selected for ligule characters. These leaves are often the only parts of the plants left in grazed or mown areas and, moreover, appear to be quite constant within limits. Ligules of the upper culm leaves are much greater in length.

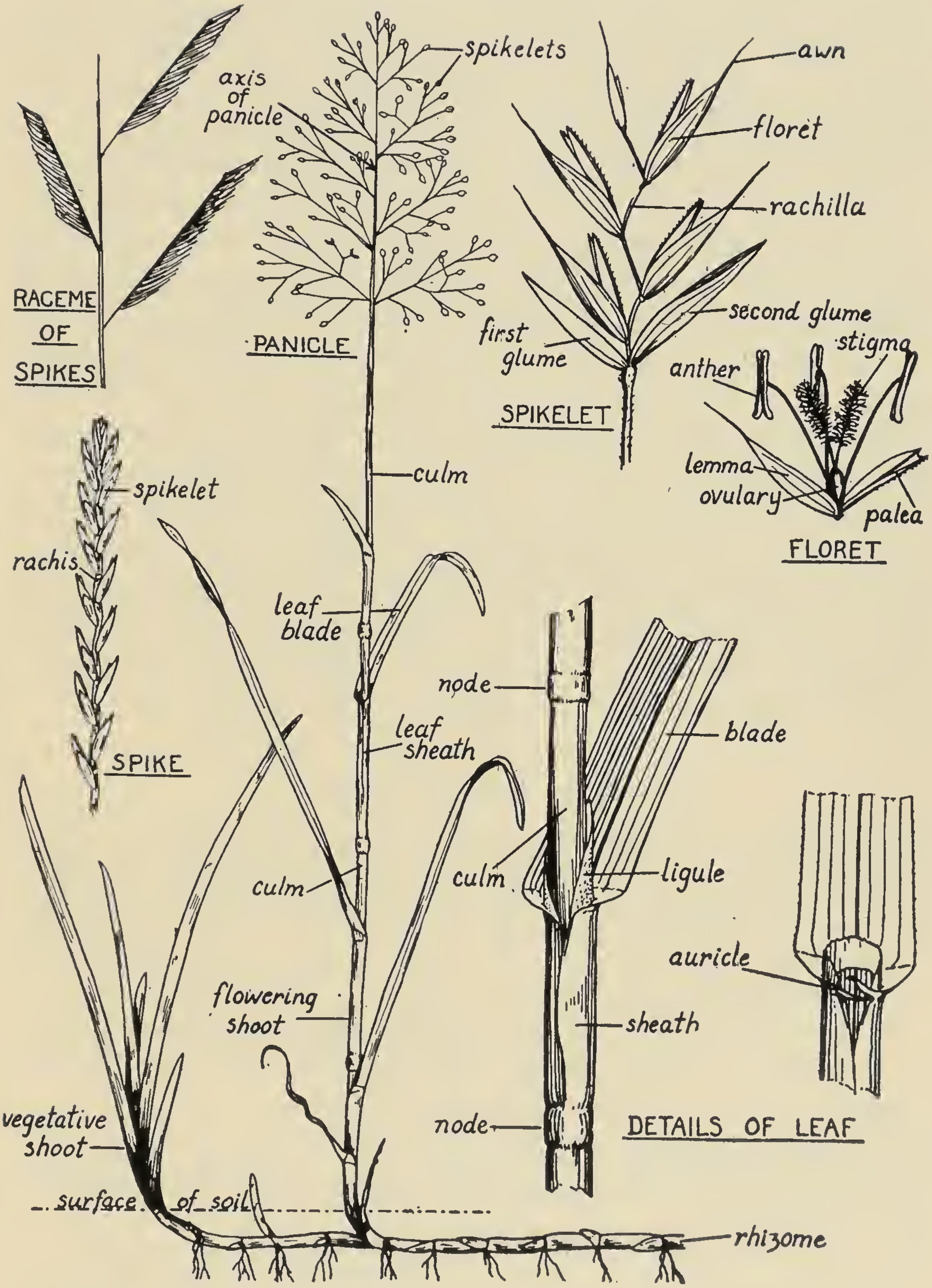
The drawings have been made to scale from dried or fresh material from the province. On the maps showing distribution, dots indicate the approximate sites of collection of specimens, the circles field records and published records that are considered reliable but for which there are no preserved specimens. The incidence of records cannot be taken as a measure of abundance of the species in any part, since some areas have been more intensively explored than others.

The authors wish to acknowledge the kindness of the following persons for examining specimens or commenting on the manuscript: H. Senn, M. L. Fernald, A. E. Porsild, G. L. Church, J. W. Swallen, R. M. Lewis. Permission of the Department of Agriculture of Nova Scotia for much of the time and facilities necessary to carry out this work is greatly appreciated.

GRAMINEAE The Grass Family

Annual or perennial herbaceous plants with fibrous roots and slender, jointed stems called culms. The culms are usually hollow between the nodes due to the early break-down of the pith, and growth in length takes place in the meristem immediately above each node. They are generally circular or oval in cross-section, but may be quite flattened as in *Poa compressa.* The culms of the grasses are thus quite different from the generally solid and three-sided stems of the Cyperaceae, a grass-like family including the sedges and bulrushes. Underground stems with scale-leaves (rhizomes) and prostrate surface runners (stolons) are often formed.

Leaves alternating in two ranks up the culm have long sheaths which envelop the culm for some distance above the nodes with the margins over-lapping along the sides opposite the blades. Closed sheaths, which frequently become ruptured with growth, are characteristic of many species of the Tribe Festuceae. The blade is linear with a prominent mid-vein and parallel secondary veins. The blades may be folded along the mid-rib (conduplicate) as in *Poa*, *Glyceria*, *Dactylis*, or they may roll in from the margins (convolute) in counter-directions in alternate leaves.


RACEME OF SPIKES
axis of panicle
spikelets
PANICLE
awn
floret
rachilla
second glume
first glume
SPIKELET
stigma
anther
lemma
ovulary
palea
FLORET
spikelet
rachis
SPIKE
culm
leaf blade
node
leaf sheath
blade
culm
culm
ligule
auricle
flowering shoot
sheath
vegetative shoot
node
DETAILS OF LEAF
surface of soil
rhizome

At the junction of the sheath and blade is a small appendage, the ligule, which projects upward around the culm and may be scale-like and membranous or represented by a row of hairs. The ligule is absent in *Echinochloa.*

The inflorescence is composed of spikelets which may be arranged in a panicle, a spike, or a raceme of spikes on the axis of the inflorescence, the rachis. Each spikelet consists of two lower scale-like bracts called glumes, and enclosed within these one or more florets arranged in alternating manner on opposite sides of the axis of the spikelet, the rachilla. Each floret has a membranous or indurated scale on the outside called the lemma, in the axil of which is a generally membranous, two-nerved scale, the palea, which is greatly reduced in size in some species of *Agrostis* or lacking in *Alopecurus.* The lemma and palea enclose the three stamens and the one-celled ovulary with its two plumose stigmas. The ovulary matures to form a grain, or caryopsis. In some florets either the stamens, the ovulary, or both, may be lacking, or the stamens reduced in number. (Poaceae)

KEY TO TRIBES

a. Spikelets 1- to several-flowered; spikelet generally breaks apart just above the glumes and between the florets at maturity; spikelets usually flattened from the sides. (SUB-FAMILY Festucoideae)

  b. Spikelets arranged in true spikes, that is, sessile on the axis of the inflorescence.

    c. Spike solitary and terminal on the culm; spikelets single, or in groups of 2 or 3, alternating along opposite sides of the axis.

TRIBE II. *Hordeae* (p. 217)

    c. Spikes several; spikelets attached singly, flattened and closely overlapping along one side of the axis of the spike.

TRIBE V. *Chlorideae* (p. 260)

  b. Spikelets in open, contracted, or occasionally spike-like panicles but not in true spikes, the individual spikelets having a short or long stalk.

d. Spikelets unisexual in different portions of the same panicle, the staminate pendent on the lower spreading branches, the pistillate on the upper erect branches and long awned; tall aquatic grasses.

TRIBE VIII. *Zizanieae* (p. 269)

d. Spikelets bisexual, although some florets in the spikelet may lack stamens, pistils or both (if spikelets unisexual their appearance not greatly different).

e. Spikelets with 2 or more florets which produce fruit.

f. Glumes shorter than the body of the first lemma; lemmas, if awned, with the awn arising from the tip or from between the two terminal teeth.

TRIBE I. *Festuceae* (p. 184)

f. Glumes as long as the body of the lemma or longer, frequently enclosing all the florets; the awn of the lemma, if present, arising from the back below the tip.

TRIBE III. *Aveneae* (p. 228)

e. Spikelets with only 1 fruit-producing floret; sterile or staminate florets, if present, being below the pistillate floret.

g. Glumes present, one may be greatly reduced in size.

h. Spikelets with only one floret, this perfect; glumes longer or shorter than the spikelet.

TRIBE IV. *Agrostideae* (p. 238)

h. Spikelets with 1 fruit-producing floret, the 2 florets below it being staminate or represented by lemmas only; glumes longer than the spikelet.

TRIBE VI. *Phalarideae* (p. 264)

g. Glumes absent; lemmas broad and flattened; plant very rough, retrorse-scabrous.

TRIBE VII. *Oryzeae* (p. 268)

a. Spikelets with 1 fruit-producing floret, the lemma of the sterile floret beneath it similar to the second glume in size and texture, the lemma and palea of the fertile floret being smooth and hard, encasing the fruit; at maturity, the spikelets fall away entire, sometimes with a cluster of bristles attached; spikelets usually flattened from the back (SUB-FAMILY Panicoideae).

TRIBE IX. *Paniceae* (p. 270)

TRIBE I. **FESTUCEAE**

a. Plants slender, generally less than 5 feet tall; inflorescence not plume-like; spikelets without conspicuous silky hairs at maturity.

b. Panicle open or contracted, but not spike-like.

c. Ligule membranous; top of sheath free from pilose hairs.

d. Sheath closed in the throat to near the top, round in cross-section; awns generally present and arising between the two teeth terminating the lemma, or just below the tip; spikelets 2 cm. long, or longer.

e. Callus of lemma not fringed with hairs; ligule not sheathing the culm; sheaths and blades generally short-pubescent; grain pubescent at summit.

1. *Bromus* (p. 186)

e. Callus of lemma with a ring of short stiff hairs; ligule encircling the culm and continuous with the membranous front of the sheath; sheaths and blades glabrous; grain glabrous,

13. *Schizachne* (p. 216)

d. Sheaths open in the throat or splitting readily down the front, on young vegetative shoots flattened and elliptical in cross-section; awns generally absent, if present merely continuations of the tip of the lemmas; blades and sheaths glabrous or, at least, not conspicuously hairy.

f. Spikelets diffuse in the inflorescence, not crowded in dense one-sided clusters.

g. Lemmas rounded on the back, at least below, lacking pubescence.

h. Lemmas acute, awned from the tapering tip in most species; nerves converging towards the tip of the lemma.

2. *Festuca* (p. 190)

h. Lemmas obtuse, rounded or acutish at the apex, never awned; nerves not as strongly convergent towards the tip of the lemma.

i. Lemma not as broad as long, the margins extending little, if at all, beyond the margins of the palea; florets ascending to spreading in the spikelet; common.

j. Nerves of lemma faint, generally 5; plants of saline or brackish soils only.

3. *Puccinellia* (p. 195)

j. Nerves of lemma prominent and sometimes raised, generally 7; plants of moist or wet, but not of saline soils.

4. *Glyceria* (p. 197)

i. Lemma as broad as long, the margins produced far beyond the palea; florets spreading horizontally in the spikelet; rare, introduced grasses.

6. *Briza* (p.211)

g. Lemmas keeled on the back, i.e. sharp along the mid-rib; awns always absent.

k. Spikelets 4 to 6 mm., rarely to 8 mm. long, on slender pedicels in erect or spreading panicles; lemma with a cottony pubescence generally present at the base and frequently also on the keel and other nerves; ligule membranous, mostly entire-margined, with no hairs at the top of the leaf-sheath.

5. *Poa* (p. 204)

k. Spikelets 6 to 10 mm. long in erect clusters; lemmas entirely free of hairs; ligule less than 1 mm. long, with a few hairs present at the top of the sheath; plants of salt or brackish places, with firm narrow blades, and scaly rhizomes.

9. *Distichlis* (p. 212)

f. Spikelets on very short pedicels, crowded in dense one-sided clusters at the ends of stiff naked panicle-branches.

10. *Dactylis* (p. 213)

c. Ligule a row of hairs less than 1 mm. long; tufts of hairs present at the top of the sheath.

l. Annual grass with lead-colored spikelets of more than 10 florets; lemmas strongly 3-nerved; minute glands present in a ring at the nodes, on keels of the glumes and lemmas.

7. *Eragrostis* (p. 211)

l. Perennial grasses; spikelets with less than 10 florets; lemmas faintly nerved; glands absent.

m. Spikelets with 2 to 4 florets; lemmas 3-nerved; florets bisexual; plants with tough fibrous roots, growing in tussocks in peaty-acid soils.

8. *Molinia* (p. 212)

m. Spikelets with 5 to 9 florets; lemmas with 5 or more faint nerves; florets unisexual, staminate and pistillate inflorescences on separate plants; plants with scaly rhizomes, forming zones in salt or brackish areas.

9. *Distichlis* (p. 212)

b. Spikelets in pairs in a slender one-sided spike-like panicle, a sterile and a fertile spikelet together, the sterile spikelet short-stalked, the fertile one sessile.

11. *Cynosurus* (p. 214)

a. Plants stout and reed-like, 6 or more feet tall; inflorescence large and plume-like; silky hairs from the rachilla of the spikelet long and conspicuous at maturity; leaves broad.

12. *Phragmites* (p. 215)

1. BROMUS L.

Inflorescence a panicle; spikelets large, 5- to 10-flowered; lemmas rounded on the back or slightly keeled in some, 5- to 7-nerved, glabrous or pubescent with straight hairs, generally toothed at apex and awned from just below the tip; stigmas attached in a groove below the apex of the ovulary; sheaths closed to near the top; ligule membranous.

a. Annuals; first glume 3- to 5-nerved.

b. Panicle contracted with erect or ascending branches with spikelets generally borne singly.

c. Lemmas glabrous.

1. *B. racemosus*

c. Lemmas pubescent.

2. *B. mollis*

b. Panicle open, with branches (the lower at least) spreading widely.

d. Sheaths glabrous, or the lowest slightly pubescent.

3. *B. secalinus*

d. Sheaths pubescent.

4. *B. commutatus*

a. Perennials; first glume 1-nerved.

e. Rhizomes present, the plant growing in dense leafy masses; lemmas not awned or with rudiments of awns less than 2 mm. long, appressed hispid across the back especially towards the base.

5. *B. inermis*

e. Rhizomes absent, the plants growing singly or spaced; lemmas awned, densely villous along the margins but glabrous up the middle of the back.

f. Spikelets generally greenish; glumes keeled; palea with the nerves appearing marginal due to infolding of the membranous edges.

6. *B. ciliatus*

f. Spikelets generally purplish or bronze-tinged; glumes flat or rounded on the back; palea with the membranous margins showing well beyond the nerves at least for more than half of its length.

7. *B. Dudleyi*

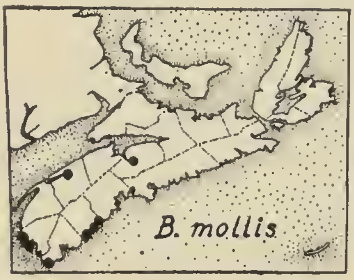
1. ***Bromus racemosus*** L.

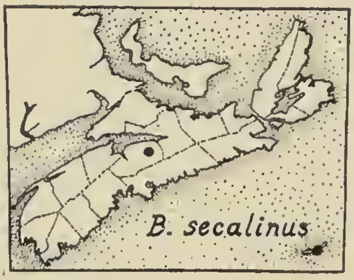
In 1922 Wiegand wrote, "Rare in America. The only American specimen seen by the writer was from a railway embankment, Grand Pré, Nova Scotia, 1901, Howe and Lang, No. 375" (*Rhodora* **24**: 90, 1922). Only in recent years have other specimens been collected: at Brooklyn, Woodville, and Cape George. Specimens collected by Macoun at Bridgewater and by Groh at Kentville and Yarmouth have been referred to *B. commutatus*, since depauperate plants of this species greatly resemble *B. racemosus*.

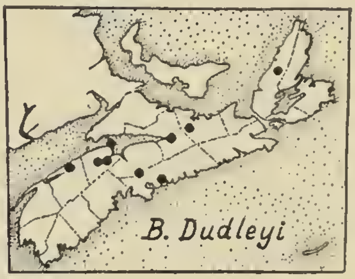
Introduced from Europe, growing as a weed in waste places.

2. ***Bromus mollis*** L. SOFT CHESS

Found in open soil, gardens, along roadways and railroad embankments mainly in the southern and western counties. This species used to be confused with *B. hordaceus*, a rare species in Europe (*Amer. Jour. Bot.* **21**: 128, 1934). No plants that could be definitely placed with the form *leiostachys* (Hartm.)Fern. (*Rhodora* **35**: 316, 1933), which has smooth spikelets, have been seen from the province.



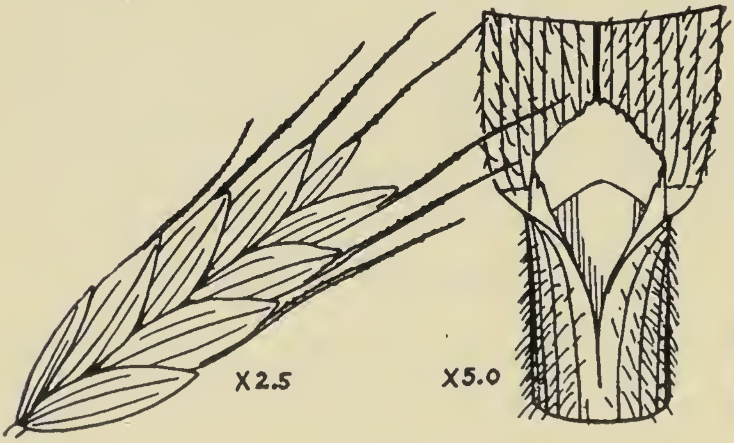


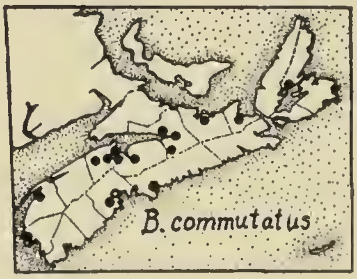


3. ***Bromus secalinus*** L. CHESS

Has been found only on "Railroad gravel along Five-Mile River (Hants)" (Fernald 1921), and in meadow grass at Sable Island in 1899 by Macoun. It has not been collected in recent years. A weed introduced from Europe and very troublesome in some parts of North America.

4. ***Bromus commutatus*** Schrad. HAIRY CHESS

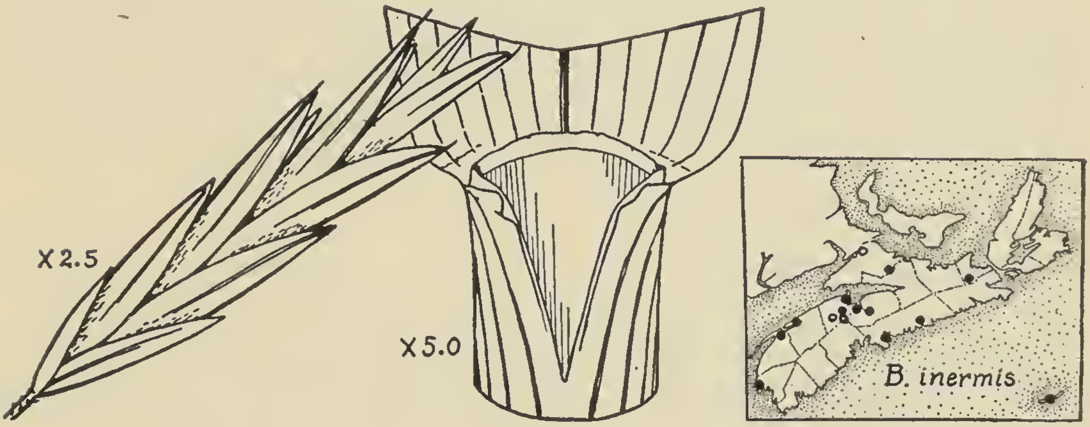




A common weed in vacant lots in towns, along roadsides and in waste places in all sections of the province.

5. *Bromus inermis* Leyss.

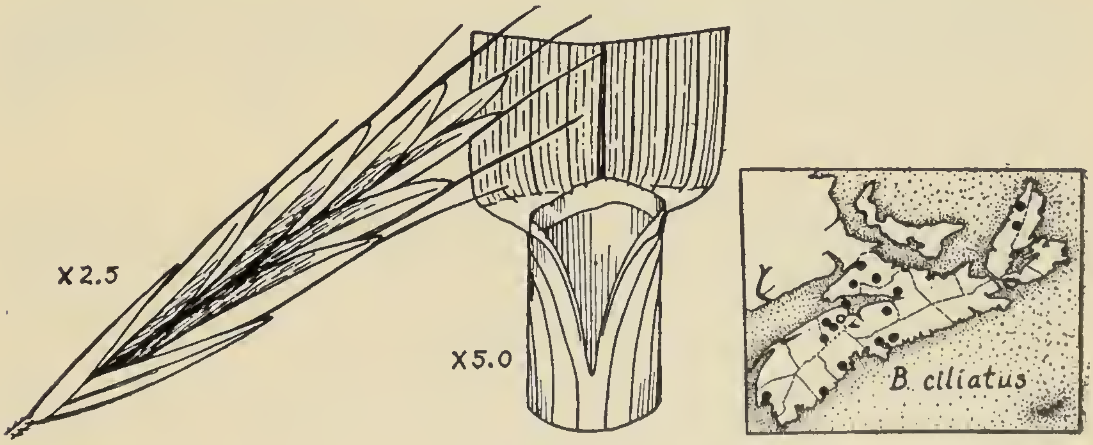
SMOOTH BROME-GRASS, AWNLESS BROME-GRASS



A valuable forage grass extensively cultivated in drier parts of Canada. In Nova Scotia the plant has been noticed to persist and spread into large colonies at a few widely separated points in the province. Found in waste ground or along roadsides; not cultivated to any extent. All our plants appear to be the form ***villosus*** (Mert. & Koch)Fern. (*Rhodora* **35**: 316, 1933).

6. *Bromus ciliatus* L.

FRINGED BROME-GRASS



A tall native species found in all parts of the province. It is a common grass of open roadsides, stream banks and old meadowlands, but never cultivated. Its value as a hay grass is not known.

Two varieties have been described (*Rhodora* **32**: 70, 1930). Most of our plants are var. ***genuinus*** Fern. (var. *denudatus* (Wieg.)Fern., *Rhodora* **28**: 20, 1926) with glabrous sheaths. A specimen of Macoun's from Bridgewater, 1910, having strongly pubescent sheaths, is var. ***intonsus*** Fern.

7. ***Bromus Dudleyi*** Fern. DUDLEY'S BROME-GRASS

Very similar to the preceding and often included with it (*Rhodora* **32**: 63, 1930). Found in open woods, clearings, roadsides and thickets in various parts of the province.

2. FESTUCA L.

Perennials with several-flowered spikelets in panicles, glabrous, or with a minute pubescence on lemmas or lower sheaths only; lemma firm, rounded on the back, obscurely nerved, tapering to a sharp or awn-tipped point; ligules less than 1 mm. long and sometimes almost obsolete.

a. Blades flat, 3 mm. or more wide; claw-like auricles present at the top of the sheath; lemmas awnless.

b. Spikelets 6- to 10-flowered, about 10 mm. long, borne throughout the panicle; lemmas 5 to 7 mm. long, thin with membranous margins. Rich meadows and pastures.

1. *F. elatior*

b. Spikelets 3- to 5-flowered, about 6 mm. long, borne on the panicle-branches only above the middle; lemmas 4 mm. long, coriaceous. Woodlands.

2. *F. obtusa*

a. Blades narrow and permanently folded; claw-like auricles absent; lemmas usually awned.

c. Lemmas 2.5 to 3.5 mm. long, awnless or with sharp tips less than 0.5 mm. long; leaves very slender, hair-like and flexuous.

3. *F. capillata*

c. Lemmas more than 3.0 mm. long, awned or mucronate-tipped; leaves coarser and stiffer.

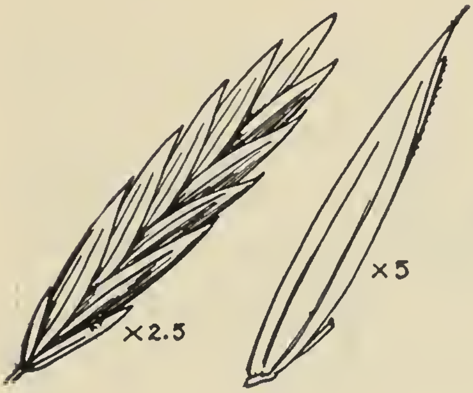
d. Basal sheaths closed to near the top, often purplish, generally minutely reflex-hirsute; dead sheaths at base of plant dark brown or red-brown, becoming fibrillose due to splitting of tissue between the tough veins. Plant generally forms a dense uniform sod by growth from short spreading basal off-shoots in the surface soil.

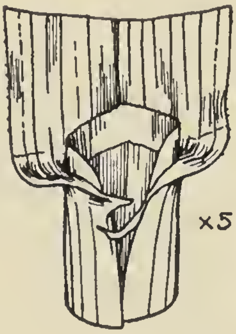
4. *F. rubra*

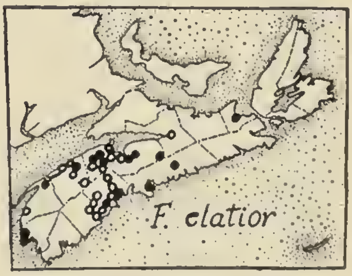
d. Basal sheaths split to near the base, whitish and cartilaginous, glabrous; dead sheaths whitish or light brown, not readily breaking up into fibrillose material. Plants densely tufted, without spreading off-shoots, consequently not forming smooth mats.

5. *F. ovina*

1. ***Festuca elatior* L.** MEADOW FESCUE







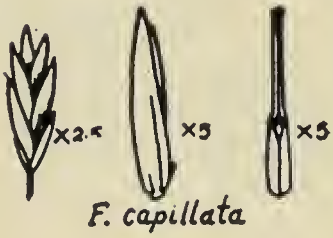
A tall leafy species easily recognized in the field by its bright green, glossy-backed blades, by the presence of auricles, and by the bright red or purple colour of the base of the fresh inner sheaths. An important forage grass frequently included in meadow and pasture seedings. It readily becomes established in Nova Scotia and persists in rich soils in fields, along roadsides and in waste places in most parts. (*F. pratensis* Huds.)

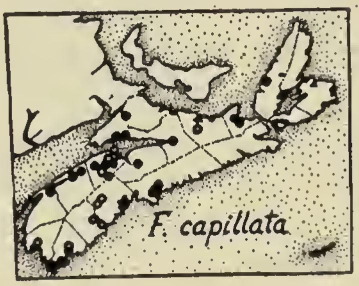
Var. **arundinacea** (Schreb.) Wimm. is a much taller and stouter plant with tough, strongly-ridged blades, coriaceous sheaths, spikelets fewer-flowered and lemmas awn-tipped. A single specimen has been seen from the province, collected by Macoun at Baddeck in 1898.

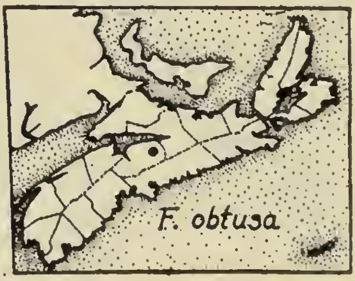
2. *Festuca obtusa* Spreng. NODDING FESCUE

A very rare woodland species reported only from Five Mile River, Hants County (Fernald, 1921). There is some doubt as to whether the old record from Halifax, published in Macoun's Catalogue has been based on authentic material, since no subsequent collection has been made in this section of the province. More abundant in the open deciduous woods on non-acid soils towards the interior of the continent. (*F. nutans* Spreng.)

3. *Festuca capillata* Lam. HAIR FESCUE

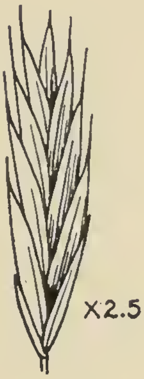


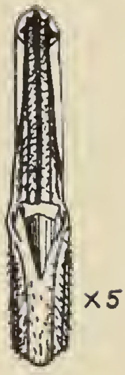


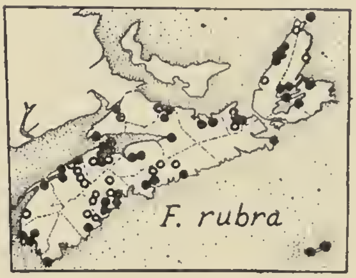


This grass, generally confused with *F. ovina* in the past, is readily recognized by its extremely fine, slender and hair-like, but very tough blades. It has no forage value and is undesirable in lawns. Found growing in tufts in dry sterile soils of pastures, lawns, and along roadsides, often occupying large areas as in Kings County and the interior of Lunenburg County. Probably introduced in agricultural seed from Europe. (*F. ovina*, var. *capillata* (Lam.)Hack.)

4. *Festuca rubra* L. RED FESCUE







A rather common grass throughout the province growing along roadsides, in pastures (particularly those in exposed situations and close to the coast), in sand and gravel along sea beaches, in the *Spartina patens* zone of the salt marshes, and sometimes even in boggy soils. Although a rather palatable grass and one well able to withstand close grazing conditions, it never becomes as abundant in our old pastures as it does in regions more inland on the continent. In lawns, some strains produce a very fine dark green uniform turf and dense sod resistant to wear.

The plant shows as great variability in its morphological characters as in the habitats in which it grows. Many subspecific types have been described by various authors, the following, with their distinctive characteristics as given in Fernald's key (*Rhodora* **35**: 132, 1933), are represented in the province.

Typical variety, spikelets 7 to 10 mm. long, 3- to 7-flowered; second glume 3.0 to 4.5 mm. long; body of first lemma 4.0 to 6.0 mm. long, glabrous; foliage green. Common throughout the province. Forma ***glaucescens*** (Hartm.)Holmb. is similar but the leaves are whitish. Found mainly on dry soil, sandy or gravelly areas by sea beaches. Forma ***megastachys*** (Gaud.) Holmb. differs from the typical form in having spikelets over

10 mm. long; 6- to 10- flowered; second glume 4.0 to 6.0 mm. long; lemma 6.0 to 8.0 mm. long. Found especially in the tidal marshes. Forma ***squarrosa*** (Fries)Holmb. has pubescent lemmas. Located in many places in the province and reported from St. Paul Island (Perry, 1931) under var. ***arenaria*** (Osbeck) Fries.

Var. ***multiflora*** (Hoffm.)Asch. & Graebn., blades flat; spikelets 10 to 17 mm. long, 6- to 10-flowered; body of lowest lemma 5.5 to 7.0 mm. long. Reported from Dartmouth (Fernald, 1922).

Var. ***juncea*** (Hack.)Richter, leaves stiff and strongly whitened; spikelets 9.0 to 20.0 mm. long, 6- to 10-flowered; body of first lemma 5.0 to 7.5 mm. long. Found along the sea coast, mainly on dry beach and dune sand.

5. ***Festuca ovina*** L. SHEEP FESCUE

This species is now found to be quite scarce in the province, the many earlier records being due to confusion with either *F. rubra* or *F. capillata.* As a lawn and pasture grass, for which it is frequently recommended, it is almost useless because of its coarse tufted and straggly type of growth. It does, however, grow well on sterile sandy and poor dry soils, and it is in such situations that it is found in the province.

Found at Kentville, Wolfville, Truro, Antigonish and undoubtedly elsewhere. The statement from Macoun's Catalogue of "Rather common on Atlantic Coast and apparently indigenous," probably applies to some variety of *F. rubra.* Macoun's specimens named *F. ovina*, var. *duriuscula* are this species. Ganong's report (1903, p. 363) from the salt marshes relates to *F. rubra* also. An examination of Lindsay's specimen from Bedford shows it to be *Poa compressa.*

Forma ***hispidula*** (Hack.)Holmb. with hispid lemmas has been found at Kentville, Wolfville and Antigonish Harbour growing with typical plants and with plants with pubescence of an intermediate type. A key to *F. ovina* and its allies in eastern North America is given by Fernald in *Rhodora* **37**: 250-251, 1935.

3. PUCCINELLIA Parl.

Glabrous perennials or biennials of wet saline or brackish soils, with narrow often inrolled leaves; spikelets 2- to many-flowered; lemmas rounded on the back, awnless, obscurely-nerved and sometimes minutely pubescent towards the base; ligule membranous. This is a difficult genus which is as yet incompletely understood. Fernald, M. L. and C. A. Weatherby, The genus *Puccinellia* in eastern North America. *Rhodora* **18**: 1-23, 1916.

a. Anthers 1.5 to 2.8 mm. long; second glume 3.0 to 4.5 mm. long; lemmas 3.5 to 5.0 mm. long, pubescent towards the base.

1. *P. maritima*

a. Anthers less than 1 mm. long; second glume up to 2.5 mm. long; lemmas 1.8 to 3.5 mm. long, glabrous or nearly so.

b. First glume 1.5 to 2.0 mm. long; second glume 2.0 to 2.6 mm. long; lemmas 2.6 to 3.5 mm. long, not ciliolate.

2. *P. pumila*

b. First glume 1 mm. long; second glume 1.3 to 2.0 mm. long; lemmas 2.0 to 2.5 mm. long.

c. Panicle stouter, dense, the branches ascending, with spikelets nearly to the base; glumes and lemmas minutely serrulate towards the tip, but not ciliolate.

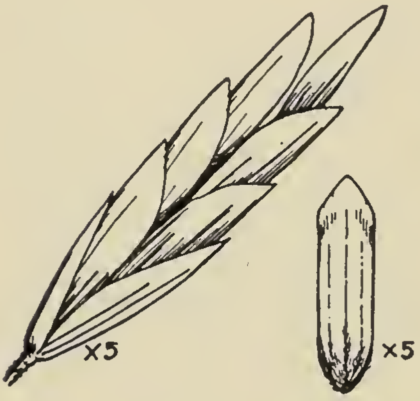
3. *P. fasciculata*

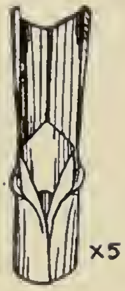
c. Panicle slender, the spreading or reflexed branches with spikelets mostly above the middle; glumes and lemmas erose-ciliolate.

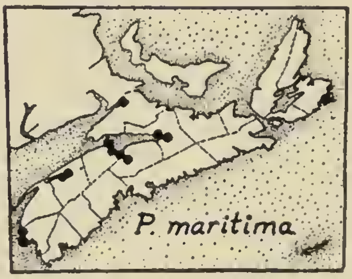
4. *P. distans*

1. ***Puccinellia maritima*** (Huds.) Parl.

SEA-SIDE PUCCINELLIA







Found commonly, but only on saline or brackish marshes from Shelburne County all along the shores of the Bay of Fundy. There is also a record from Louisburg (Macoun, 1888). Nova Scotia to Rhode Island.

2. ***Puccinellia pumila*** (Vasey) Hitchc. DWARF PUCCINELLIA

Widespread along the seashores of the province; but also found at inland points around salt springs, as at Oxford. (*P. paupercula* (Holm.) Fern., var. *alaskana* (Scribn. & Fern.) Fern. & Weath.); (*P. angustata* in Britton & Brown). Labrador, south to Connecticut.

3. ***Puccinellia fasciculata*** (Torr.) Bicknell

A smaller, more densely flowered species than the preceding two; found rarely at the heads of salt marshes or on dykelands on the Fundy side of the Province. Collected at Kentville and Grand Pré. Mentioned in Britton and Brown under the name *P. Borreri*, as ranging to Nova Scotia. Nova Scotia to Delaware; Europe.

4. ***Puccinellia distans*** (L.) Parl. SPREADING PUCCINELLIA

Occurs in waste places along roadsides as well as on salt or brackish mud around the towns of Sydney, Pictou, and

Windsor; appearing as if introduced from the Old World in ballast. Widely spread in eastern North America.

4. GLYCERIA R. Br.

Plants of moist or aquatic habitats, lacking hairs throughout; inflorescence an open or contracted panicle; spikelets 2- to 12-flowered; lemmas awnless, rounded on the back, generally with 7 distinct and often raised nerves, smooth to scabrous; leaf-blades (except in *G. Fernaldii* and *G. pallida*) without ridges on the upper surface and folded along a conspicuous mid-rib; sheaths closed, at least during early stages; ligule membranous. (Panicularia)

One or more of the following characteristics will distinguish these grasses from related genera: the several-flowered spikelets with glumes shorter than lemmas; the 7, often prominently raised, nerves of the round-backed lemmas; and the moist, but never brackish, habitat.

a. Spikelets elongate, 10 mm. long or longer, lying closely along the branches of the panicle on short pedicels.
  b. Leaves 2 to 4 mm. wide, rarely to 6 mm.; lemmas 3 to 4 mm. long, smooth or nearly so between the slightly roughened nerves.
    1. *G. borealis*

  b. Leaves 4 to 8 mm. wide; plant coarser; lemmas 5.0 to 6.5 mm. long, minutely roughened between the nerves.
    2. *G. fluitans*

a. Spikelets ovate or oblong, less than 7 mm. long, on more diffuse branchlets.
  c. Panicle contracted with closely ascending branches.
    d. Panicle oblong and dense, erect, 12 cm. long or less; lemmas 3 to 4 mm. long.
      3. *G. obtusa*

    d. Panicle linear, rather open and often nodding, 15 to 25 cm. long; lemmas 2.0 to 2.3 mm. long.
      4. *G. melicaria*

c. Panicle loose with more or less spreading or drooping branches.

  e. Nerves of the lemmas not prominently raised; edges of the bowed-out palea visible beyond the edges of the lemma.

    f. Spikelets with 5 to 10 florets; lemma 3 to 4 mm. long.

      5. *G. canadensis.*

    f. Spikelets with 3 to 6 florets; lemma 2.0 to 2.5 mm. long.

      5a. *G. canadensis*, var. *laxa*

  e. Nerves of the lemmas prominent; palea not bow-shaped.

    g. Stems usually stout, erect.

      h. Panicle mostly less than 20 cm. long; spikelets 3 to 4 mm. long, with the first glume 1 mm. long or shorter.

        i. Leaves flat, to 7 mm. wide; panicle 10 to 30 cm. long; spikelets mostly greenish, with the smaller lemmas (mainly 1.5 to 1.8 mm. long) merely scarious-tipped.

          6. *G. striata*

        i. Leaves mostly folded, to 4 mm. wide; panicle 5 to 15 cm. long; spikelets mostly purplish with the larger lemmas (2.0 to 2.2 mm. long) rounded with broad rounded tips.

          6a. *G. striata*, var. *stricta*

      h. Panicle large and ample, 15 to 40 cm. long; leaves 7 to 12 mm wide; spikelets 5 to 6 mm. long, with the first glume 1.2 to 1.5 mm. long.

        7. *G. grandis*

    g. Stems soft and weak, lying partly on the ground; spikelets pale green, scabrous.

      j. Plant 3 to 10 dm. high; leaves mostly 4 to 8 mm. wide; spikelet 4- to 7-flowered, 6 to 7 mm. long; anthers 1 mm. long.

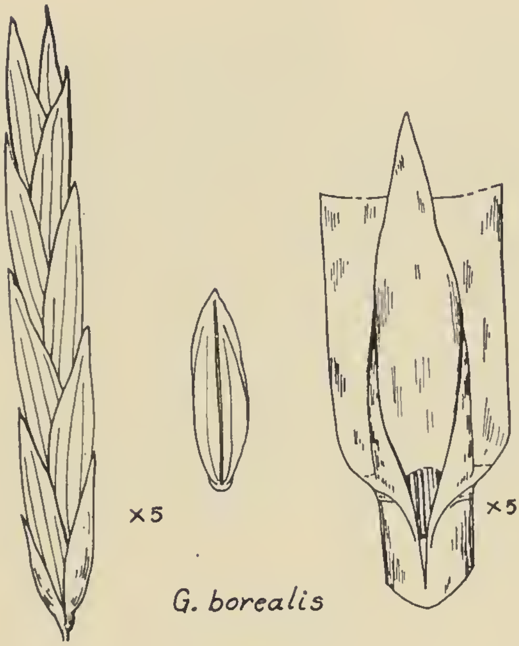
        8. *G. pallida*

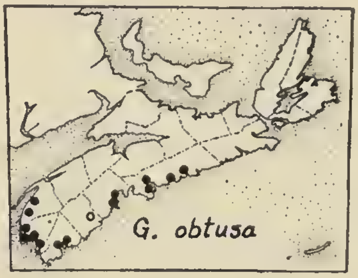
      j. Plant 2 to 4 dm. high; leaves 1 to 3 mm. wide; spikelet 3- to 5-flowered, 4 to 5 mm. long; anthers 0.4 to 0.6 mm. long or less.

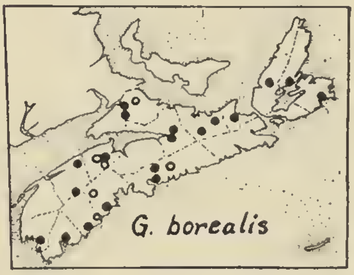
        9. *G. Fernaldii*

1. *Glyceria borealis* (Nash) Batchelder

NORTHERN MANNA-GRASS







Growing in quiet shallow waters in pools and streams, around the margins of lakes, in ditches, the long narrow leaves often floating on the surface of the water; also in very wet soil. Common throughout the province. Distributed across the continent.

A plant with larger stalks and broader spikelets collected in a shallow ditch at Meteghan, Digby County (Dore, no. 745, August 9, 1940), has been found by G. L. Church of Brown University to have 40 chromosomes, twice the number of *G. borealis*, but the same as in *G. septentrionalis* Hitchc. The specimen, however, lacks the distinct scabridity of the lemmas, which typifies *G. septentrionalis.*

2. *Glyceria fluitans* (L.) R. Br. FLOATING MANNA-GRASS

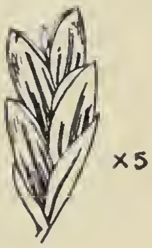
Similar to the preceding, but distinguished by its larger, stouter spikelets, longer lemmas and stouter growth. Abundant in swales, ditches and wet meadows around the marshes near

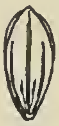
Truro (Roland, 1941); unknown elsewhere in the province. Introduced from Eurasia to eastern North America.

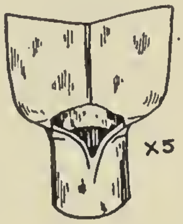
3. *Glyceria obtusa* (Muhl.) Trin. BLUNT MANNA-GRASS

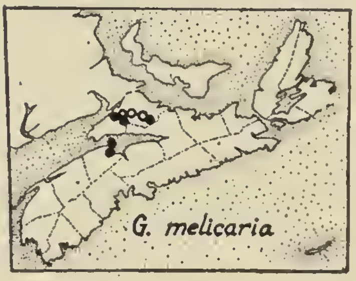
The stiff upright growth of the stems and leaves with the compact dense panicles of large spikelets, and the short ligule about 1 mm. long, are good field characteristics. Common in Yarmouth and southern Digby Counties, eastward at least to Lunenburg County, and scattered to Musquodoboit Harbour in Halifax County. In some places it makes dense stands 3 to 4 feet high with panicles 17 to 20 cm. long (Fernald, 1922, p. 161). Swales, wet muck soils and boggy margins of streams and lakes. Found only near the Atlantic coast from N. S. to North Carolina. (Map p. 199).

4. *Glyceria melicaria* (Michx.) F. T. Hubb. LONG MANNA-GRASS





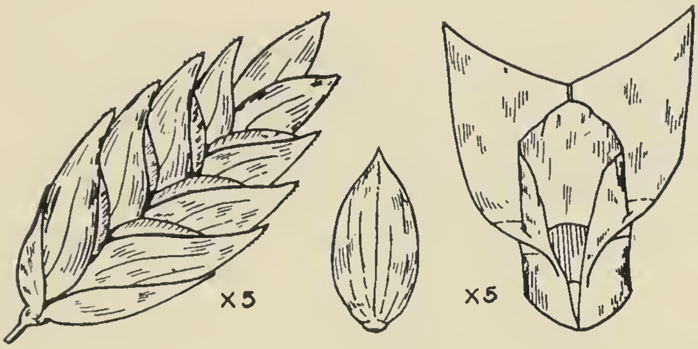


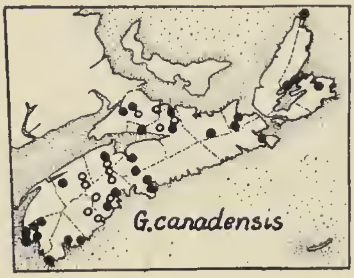


Identified best, when growing, by the long erect or nodding, narrow panicle; or, if confused with species of *Poa*, by the closed sheath. Abundant in rich, wet woods, damp thickets and along shady brooksides, often becoming the dominant grass over small areas; from Cape Blomidon northward through Cumberland County, eastward at least to Folleigh Lake and probably beyond. There is a specimen collected by M. S. Brown from a doubtful station in Halifax County. Extending eastward and southward from N. S. (*G. elongata* Trin.; *G. Torreyana* (Spreng.)Hitchc.)

5. ***Glyceria canadensis*** (Michx.) Trin.

RATTLE-SNAKE MANNA-GRASS

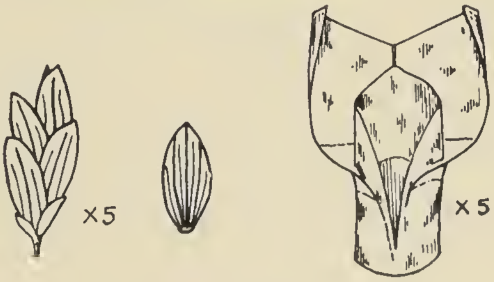


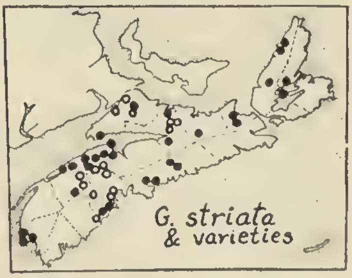


One of the handsomest of our native grasses with its large turgid yellowish-green spikelets pendent from long slender branches of an ample panicle. When young the spikelets are almost terete, but soon after flowering the lemmas spread widely and expose the bowed out keels of the paleas. Common throughout the whole province, in well-drained swamps, boggy land, springy woods and ditches, wet meadows and grassy borders of streams and ponds, sometimes even in sphagnous bogs. General in distribution in eastern Canada and north-eastern U. S. A.

5a. Var. ***laxa*** (Scribn.) Hitchc. Much taller than the preceding, often growing in large pure colonies. Scattered in occurrence from Digby and Yarmouth Counties to Hants and Halifax Counties; also in Cape Breton Island. Restricted in Canada and the U. S., unlike the species, to eastern regions. P. E. I. to West Virginia, but also in Michigan.

6. ***Glyceria striata*** (Lam.) Hitchc. FOWL MANNA-GRASS





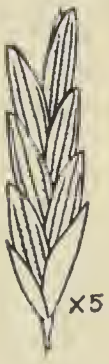
Common throughout the province in moist rich soils in meadows, ditches, along streams and wet open woods. The spikelets vary somewhat in length and in the number of florets. Ranges throughout the temperate parts of the continent. (*G. nervata* (Willd.)Trin.)

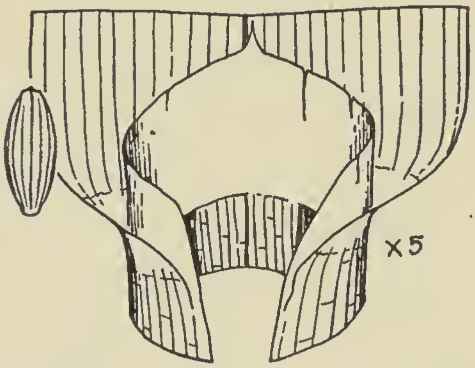
The tall, slender woodland form with sparse open panicle of widely-spreading branches and smaller green spikelets 2 to 3 mm. long, 3- to 4-flowered, with lemmas 1.2 to 1.8 mm. long, has been named *G. nervata*, var. *parviglumis* Scribn. & Merr. This is found in Kings, Annapolis and Yarmouth Counties. As a variety it is scarcely distinct since all intergrades with the species can be found; and it is better considered merely as an ecological form.

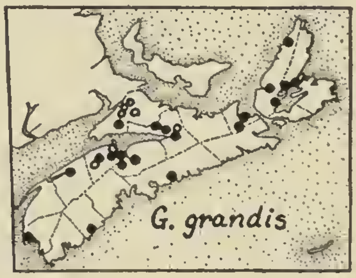
6a. Var. **stricta** (Scribn.)Fern. (*Rhodora* 31: 48, 1929) is a smaller and stricter form with a purplish tinge to sheaths and panicle. Found in similar or more open and drier situations than the species; probably more common in the province. In moist meadows and pastures it may provide considerable fodder. A more northern variety ranging from Labrador to Alaska south to N. S., Maine, and along the Rocky Mountains.

7. **Glyceria grandis** S. Wats.

REED MANNA-GRASS, AMERICAN MANNA-GRASS







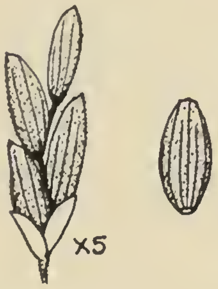
Culms stout, 10 to 15 dm. high, with wide flat leaves and ample erect panicle of numerous small purplish spikelets with pale glumes. The minute cross-veins stand out in the sheaths and blades. Found throughout the province in wet meadows, banks of streams, marshes; often conspicuous in swales and ditches particularly in the northern and western tier of counties. Readily eaten by cattle. P. E. I. to Alaska southward.

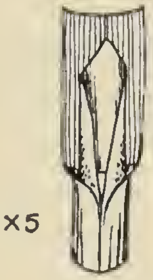
Forma **pallescens** Fern., with yellowish spikelets, has been reported from Yarmouth (Fernald, 1921) and since found in Kings County at numerous places from Grand Pré to Coldbrook growing in patches and often admixed with the typically purple-panicled plants. Also known from Maine.

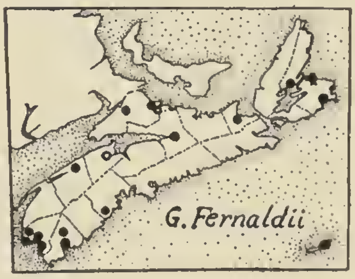
8. **Glyceria pallida** (Torr.) Trin. PALE MANNA-GRASS

A pale green, lax, medium-sized grass known at the present time only from collections from "boggy swales and savannahs of the Tusket River, Yarmouth Co." (Fernald, 1921). The earlier records from Cape Breton Island and Lunenburg County are to be referred to *G. Fernaldii.* A collection from near Amherst is intermediate in some respects. This and the next are probably not specifically distinct. N. S. to Wisconsin, south to North Carolina.

9. **Glyceria Fernaldii** (Hitchc.) St. John
SMALL MANNA-GRASS







Resembling the last, but smaller throughout, often reclined in the bottom of cat-tail marshes, swales, margins of ponds, ditch bottoms; abundant in its proper habitat throughout the province. This grass has often passed under the names of *G. pallida*, var. *Fernaldii* Hitchc. (*Rhodora* 8: 211, 1906) or *G. neogaea* Steud. (Kelso, L. *Rhodora* 35: 225-226, 1933). Range is more northern than *G. pallida*: Nfld. to Minnesota, south to Connecticut.

5. POA L.

Plants without pubescence on the leaves and stems; leaves with narrow blades which are folded along the mid-vein in the young shoot; ligules membranous; inflorescence an open or only loosely contracted panicle; spikelets 2- to 5-flowered, flattened so that the glumes and lemmas become a keel along the mid-nerve; lemmas always awnless, with 5 nerves, the two intermediate ones often obscure, generally with a coiled tuft of long, webby hairs arising from the callus and frequently with soft pubescence on the mid-nerve and other nerves. The great variation of several members of this genus makes this an extremely difficult group to classify adequately.

a. Low annual or winter-annual, less than 25 cm. high, with light-green leaves; webby hairs at base of lemma lacking or, rarely, short and scant; panicle-branches arising singly or in pairs; keel and marginal nerves of lemma pubescent.

1. *P. annua*

a. Perennial, usually much taller; webby hairs present at base of lemma.

b. Plants with long rhizomes; keel and marginal nerves of the lemma pubescent.

c. Culm flattened, 2-edged; leaf-blades short and tapering to the tip, generally a bluish- or glaucous-green color, glabrous; webby hairs at the base of the lemma scant; panicle branches usually in pairs.

2. *P. compressa*

c. Culm round in cross-section; leaf-blades often long and narrow with parallel sides and abruptly-pointed tip, generally dark green, sometimes minutely pubescent on upper surface.

d. Panicle with many spikelets on slender branches borne mostly five at each node of the panicle; spikelets 3.0 to 5.0 mm long; common.

3. *P. pratensis*

d. Panicle with a few spikelets on short, stiff branches arising singly or in pairs from each node; spikelets 5.5 to 7.0 mm. long; rare, in mossy woods

4. *P. costata*

b. Plants tufted and lacking rhizomes, often decumbent at the base or somewhat sprawling.

e. Marginal nerves of the lemma not pubescent, the keel glabrous or pubescent.

f. Ligule of lower leaves 2 to 6 mm. long; spikelets numerous; panicle-branches several at each node.

5. *P. trivialis*

f. Ligule 1 mm. long or less; spikelets few at the ends of slender nodding branches of the panicle.

g. Keel of the lemma pubescent; panicle-branches more than 2 at each node.

6. *P. alsodes*

g. Keel of the lemma glabrous; panicle-branches in pairs or solitary.

7. *P. saltuensis*

e. Marginal nerves, as well as the keel, pubescent.

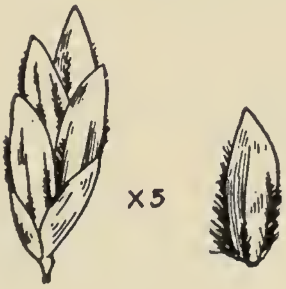
h. Ligule on lower leaves less than 1 mm. long.

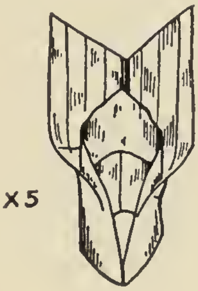
8. *P. nemoralis*

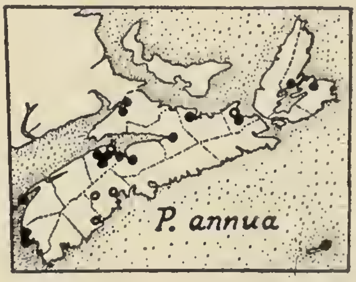
h. Ligule on lower leaves 1 to 4 mm. long.

9. *P. palustris*

1. ***Poa annua*** L. ANNUAL BLUE-GRASS







This species, easily recognized by its light green foliage, low-growing habit and abundant panicles, is a common weed in gardens, lawns, dooryards, along paths, and in pastures around the gateway and drinking troughs where heavy trampling keeps down taller-growing species. Flowering starts early in the spring and continues until frost, with sometimes a dormant period in the dry mid-summer. New plants arise from seed or from the old stalks that winter over.

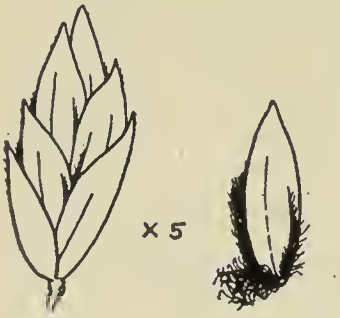
A common weed throughout the province. Introduced from Europe and widely distributed.

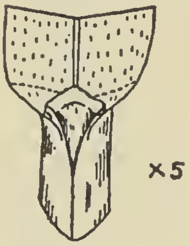
2. *Poa compressa* L. CANADA BLUE-GRASS

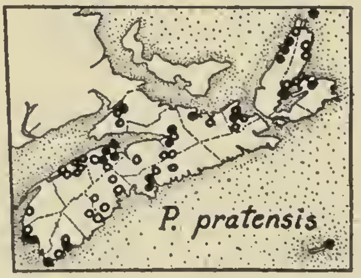
This rhizomatous species sends up spaced tough stalks somewhat geniculate at the base but lacking the abundance of vegetative shoots and basal leaves, and turf-forming properties of *P. pratensis*. The sheaths soon turn whitish and become conspicuous against the green blades and culms. This feature, together with the distinctly flattened culms, longer and whiter ligule and later flowering, readily distinguishes this plant from *P. pratensis*, with which it is frequently confused.

In Nova Scotia *P. compressa* seems to be restricted to the highly aerated soil such as can be found in the sod overhanging a ditch or road-cut, in pockets on flat rocks, where frost-heave has loosened up the ground, or in beach gravels and sands. Found in most regions of the province, but not nearly as common as the next. A good forage species, but established only in favoured situations. Not suitable for lawns. Introduced from Europe; throughout North America, and well adapted to conditions in the Great Lakes region.

3. *Poa pratensis* L. KENTUCKY BLUE-GRASS







One of the commonest species in pastures, meadows, lawns and roadsides in all parts of the province. Due to its long rhizomes which spread under the surface, the plant is able to survive under conditions of continual grazing, close clipping and trampling, forming a tough sod with an abundance of narrow leaves.

The great variation found in the habit and morphology of this species has given rise to some confusion in the classification of its sub-specific states. Development of the seed is known to take place asexually by nucellar budding allowing the same combination of genetic characters to be preserved unchanged from generation to generation. A great variety of habit types are therefore to be found in nature, their appearance showing some correspondence with ecological conditions. In old pastures and in exposed uplands, low-growing, broad-leaved forms occur. Many types have narrow blades (var. *angustifolia* (L.) Sm.). Large coarse plants in bogs and humid uplands are related to the northern variety **alpigena** Fries. Certain abnormal spikelets are formed when the florets become infected by nematodes, similar to the case of *Agrostis tenuis*, and such plants may be confused with the next species.

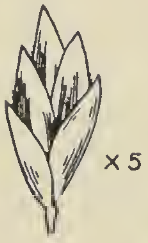
Introduced from Europe. One of the most valuable forage and turf-forming grasses in moist temperate regions. In areas subject to mid-summer drought, the plant exhibits a striking dormancy.

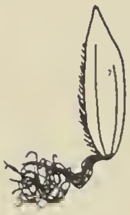
4. **Poa costata** Schum.

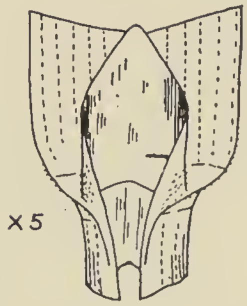
A delicate and rare grass found in damp, mossy woods and glades or thickets at Middleton, Port Bevis and Truro. Also found in P. E. I. and Nfld. and thought to be the same as the plant of northern Europe (Fernald, M. L. *Rhodora* **23**: 133, 231, 1921).

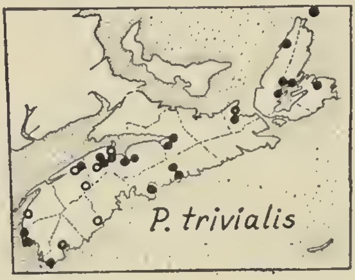
Examination of the Nova Scotian specimens shows all to be highly parasitized by nematode worms (Dore, W. G. *Rhodora* **44**: 246-247, 1942). Similar infection in *P. pratensis* causes abnormal changes of the flowering parts so that the plants become very similar in their dimensions and structure to *P. costata*. It may be suspected, therefore, that the North American plants that have been called *P. costata* in the past may be nothing more than *P. pratensis* or some other local species with all spikelets infected. The vegetative characteristics are similar to those of *P. pratensis*.

5. ***Poa trivialis*** L. ROUGH-STALKED BLUE-GRASS









Plants without rhizomes, upright from a decumbent base, pale green or with the sheaths tinged with purple; culms and sheaths more or less scabrous; ligule 2 to 6 mm. long, pointed; flowering until frost. Individuals in shaded or excessively moist situations are weak and sprawling with 1- or 2-flowered spikelets and narrow glumes, appearing very different from the typical plant.

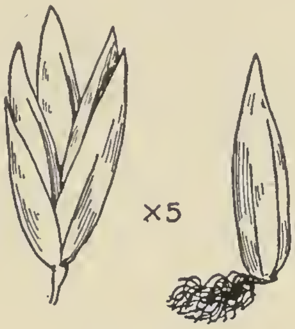
An abundant species in good land throughout the province. A valuable forage grass growing well both in hay and as a bottom grass in pastures. The plant persists and spreads on its own accord, being more successful here than in the interior of the continent. Introduced from Europe to many places of North America, often appearing as if native to this province.

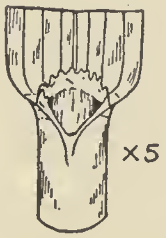
6. ***Poa alsodes*** A. Gray

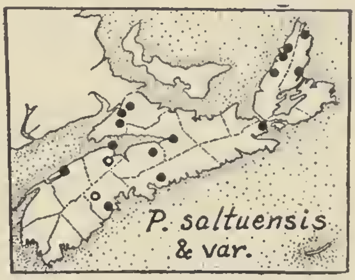
Recorded in Lindsay's Catalogue from Dartmouth. There is no specimen, however, to substantiate this in his collection in the Provincial Museum. The plant was collected in 1940 on a stream bank in deep woods at Cheticamp and is evidently very rare in N. S. Found in rich woods, westward to Minnesota and south to Tennessee.

7. ***Poa saltuensis*** Fern. & Wieg. FOREST MEADOW-GRASS

A woodland species with tall, slender, culms, sheaths closed to near the top, and drooping panicles with few spikelets. Plants typical of the species have panicles 10 to 20 cm. long, spikelets 3-flowered, 4.5 to 5.0 mm. long, and lemmas 3.5 to 4.0 mm. long. Plants with smaller panicles 6 to 10 cm. long, spikelets 2-flowered, 3.5 to 4.0 mm. long, and lemmas about 3.0 mm. long have been segregated as var. ***microlepis*** Fern. & Wieg. (*Rhodora* 20: 124, 1918). Much of the Nova Scotian material appears to be this variety but the separation is not clear-cut. (*P. debilis* Torr. and *P. debilis*, var. *acutiflora* Vasey in Macoun's Catalogue, 1888)







Found in rich and mossy hardwoods, in brookside thickets, and on the rocky shaded banks. Nfld. to Minnesota, south to Delaware.

8. ***Poa nemoralis*** L. WOOD BLUE-GRASS

Similar to the next, but with the glumes narrower and more slender-pointed and the ligule of the lower leaves less than 0.5 mm. long.

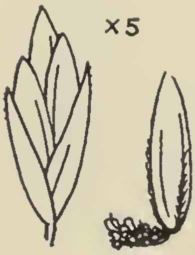
The only specimens seen from the province are from a shady lawn at Antigonish and dry wooded bank at Kentville.

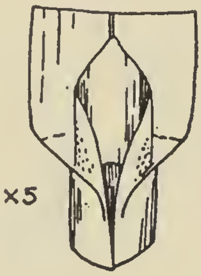
Introduced from Europe and occasional from Nfld. to Delaware and Michigan.

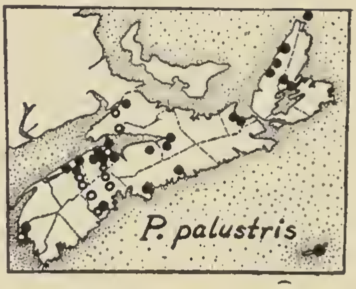
9. ***Poa palustris*** L.

FOWL BLUE-GRASS, SWAMP MEADOW-GRASS

A tall grass with ample panicle common in moist situations throughout the province. The spikelets are frequently 3-flowered with the tips of the lemmas bronze-tinged. The taper-pointed blades frequently stand erect on the culm, giving a characteristic field appearance. Ligules are long, those of the lower culm leaves 1 to 4 mm. long. In the absence







of other parts *P. palustris* may be distinguished from *P. pratensis* by this point, the ligules in the latter being less than 1 mm. long.

The extreme variations that occur in this species due to habitat and stage of growth have led to much taxonomic confusion. The plant is best developed in moist meadows and along stream banks. In drier sites and pastures it has a stricter growth with sparser panicles; in deep shade the plant is weak and the panicle reduced to a few small spikelets; autumnal forms are decumbent, sending up numerous flowering tillers. (*P. triflora* Gilib., *P. serotina* Ehrh.)

Common in all parts of the province. Found from Nfld. southward, also on the West Coast and in Eurasia.

Poa alpina L.

Mentioned by Fernald as occurring in Cape Breton (Mem. Gray Herb. II: 314, 1925) and ranging into N. S. according to Gray's *Manual.* No specimen from Nova Scotia has been seen by the authors.

Poa caesia Sm.

The record for Windsor in Macoun's Catalogue, 1888, has not been substantiated. (*P. glauca* Vahl)

6. BRIZA L.

Small perennial with open panicle, and large spikelets pendulous from the ends of flexuous capillary branches; spikelets about 10-flowered, orbicular in shape; lemmas broad and cordate at the base, smooth and faintly nerved, spreading at right-angles from the axis of the spikelet.

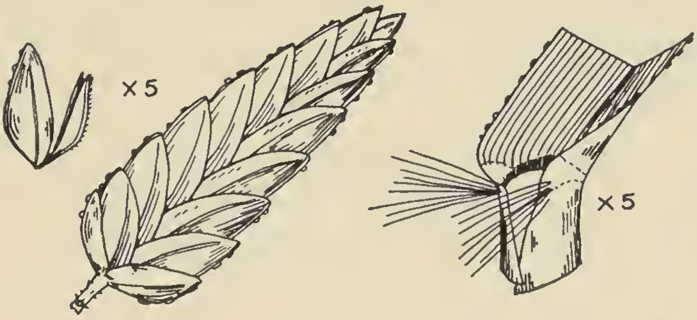
1. *Briza media* L. QUAKING-GRASS

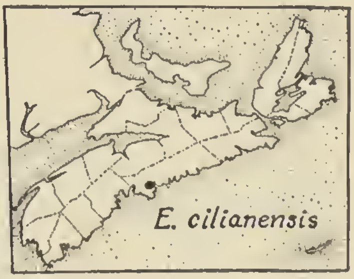
The only record of this grass in the province is based on Macoun's collection made in ditches at Digby in 1910. The plant is sparingly introduced from Europe, where it grows in fields and meadows. It does not, however, grow well on this continent.

7. ERAGROSTIS Beauv.

A weedy annual, with numerous small glands giving off a disagreeable odor; panicle large, with numerous many-flowered spikelets; lemmas soon fall away leaving the paleas on the rachilla and allowing the grains to shed readily. Our species is readily recognised by the 10- to 40-flowered spikelet, by the glands on the foliage, on flowering parts and in a ring just below the nodes, by the tuft of fine hairs at the top of the sheath and by the ciliate ligule.

1. *Eragrostis cilianensis* (All.) Link STINK-GRASS





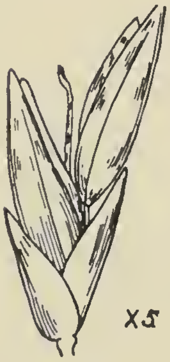
The plant was collected in 1938 in waste land about Halifax Harbour, but undoubtedly occurs in ballast and in similar places elsewhere in the province. Introduced from Europe and becoming a common weed in America. (*E. major* Host)

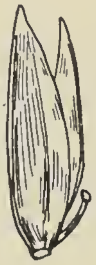
8. MOLINIA Schrank

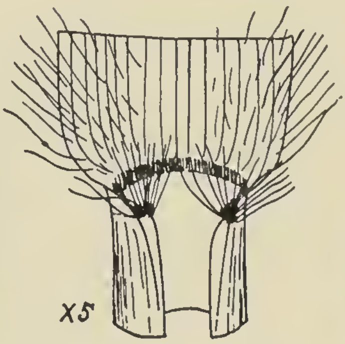
Coarse grass 5 to 10 dm. high, with long tapering leaves 2 to 8 mm. wide; panicle large and elongated with 2- to 3-flowered spikelets; glumes and lemmas smooth and purple-tinged; ligule ciliate; hairs present at the top of the sheath and towards the base of the blade.

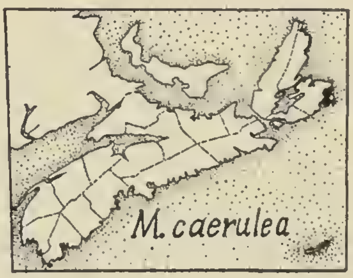
1. ***Molinia caerulea*** (L.) Moench

FLYING BENT, PURPLE HEATH-GRASS







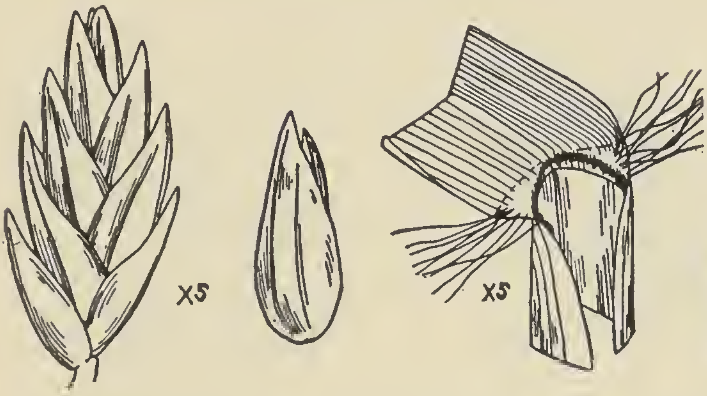


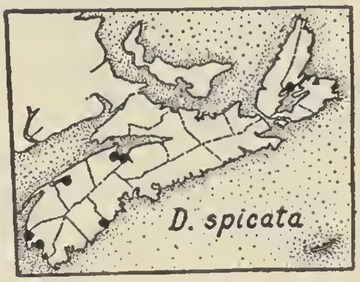
A common grass of upland moors of northern Europe; introduced into America in only a very few localities in the eastern United States and Newfoundland. Collected for the first time in Canada in 1940 around the town of Louisburg where the extensive stands indicate its establishment there for a long time (Roland and Dore, 1942). The leaves are coarse, tough and break off at the ligule region at maturity leaving large tussocks of sheaths and culms anchored firmly in place by extremely tough and persistent fibrous roots. Sheep can graze it only when the leaves are young in the spring.

9. DISTICHLIS Raf.

Small grasses 1 to 4 dm. high with numerous rigid sharp-pointed leaves; staminate and pistillate spikelets in separate plants, 5- to 9-flowered, compressed so that the lemmas and glumes are sharply keeled; panicle dense and stiffly erect.

1. ***Distichlis spicata*** (L.) Greene SEASHORE SALT-GRASS





Found only along the coast where the soil is affected by the salt or brackish water, generally forming extensive colonies in the upper parts of the marshes or just above high tide on the sandy shores. Not common, but scattered along the Bay of Fundy and up the Atlantic Coast. Around much of the coast of North and South America, and inland around salt springs or in saline soil.

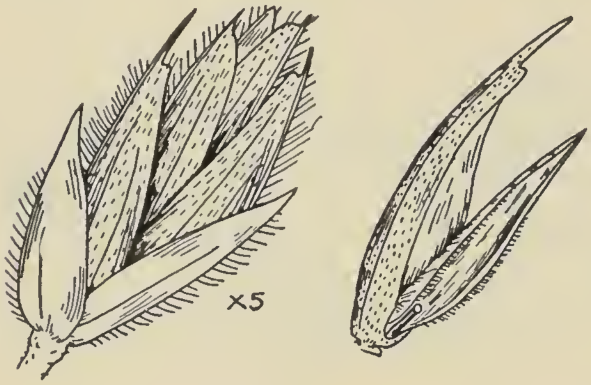
10. DACTYLIS L.

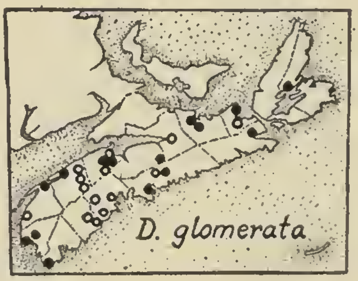
Tall, tufted perennial grass with broad, smooth blades keeled along the prominent mid-rib; spikelets 3- to 8-flowered, much compressed, almost sessile and crowded in clusters along or at the ends of the stiff panicle-branches; keels of the glumes and lemmas conspicuously ciliate; ligule long and membranous.

1. ***Dactylis glomerata*** L. ORCHARD-GRASS, COCKSFOOT

A valuable forage grass used extensively in pastures and hay fields in Britain and other parts of Europe. It is essentially a hay type with upright shoots and leaves, but low-growing, leafy strains have been developed especially for grazing purposes. In Nova Scotia it is not sown to any extent, although the grass may be found in most parts of the province growing wild in fields around towns, along roadsides and in orchards.

Numerous varieties have been proposed by European workers. In Nova Scotia the ***typical*** variety, with the backs of the glumes and lemmas essentially glabrous, is the most common. Var. ***ciliata*** Peterm., with pubescent glumes, lemmas and sheaths, and var. ***detonsa*** Fries, with the keels of the glumes and lemmas merely scabrous rather than long-ciliate, are also found. Widely introduced from Eurasia.





11. CYNOSURUS L.

Low grasses, with slender spike-like panicles and the spikelets sessile or on very short pedicels arranged along one side of the axis; spikelets of two kinds in the same inflorescence, the sterile ones with scale-like parts and short pedicels, the fertile ones situated at the base of the sterile and with 2 or 3 florets; ligule membranous.

1. *Cynosurus cristatus* L. CRESTED DOG-TAIL

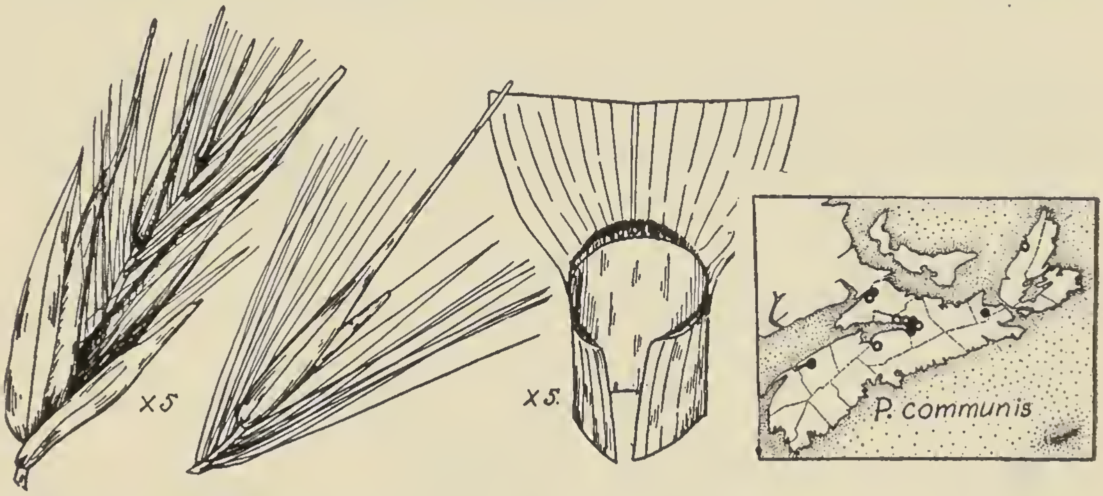
A common species of meadows and pastures in northern Europe, and known in Newfoundland. Collected but once in Nova Scotia, on a roadside at Baddeck in 1936, by Groh.* Introduced in scattered places from Nfld. to Virginia, and on the West Coast. Considered to have only slight forage value.

* Found growing abundantly in old pasture fields west of Kentville, late Aug. 1942.

12. PHRAGMITES Trin.

Tall, perennial, broad-leaved reed-like grasses growing in dense thicket-like stands from stout rhizomes, and producing late in the season large silky panicles at the top of the stalks; spikelets several-flowered, the flowers successively smaller, and with long silky hairs growing from the rachilla; ligule brownish, of matted hairs.

1. *Phragmites communis* Trin. COMMON REED



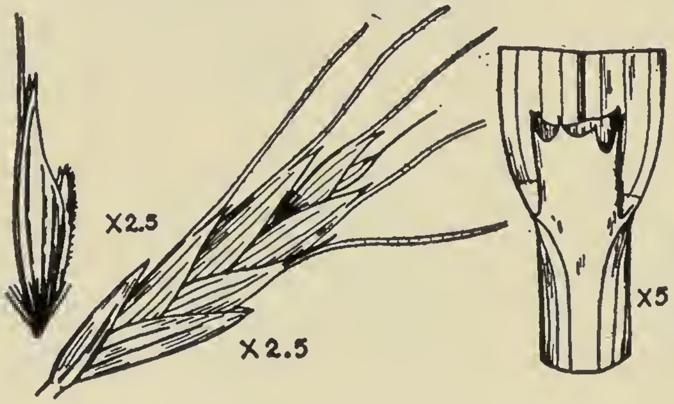
This is the largest grass in the province with an average height of 6 to 7 feet, sometimes attaining as much as 10 feet. The culms are large, smooth, tough and shaft-like, with leaf-blades an inch or more in width. The American plants, including all those found in Nova Scotia, with their greater stature, longer spikelets and glumes, have been separated from the European plant as var. ***Berlandieri*** (Fourn.)Fern. (*Rhodora* **34**: 211, 1932).

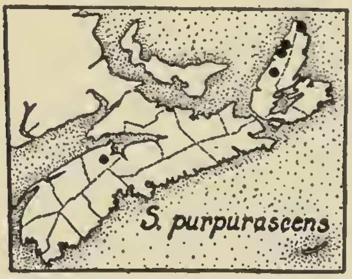
Found along the upper borders of salt marshes, or just behind them, in wet partly-brackish situations. About Amherst this grass is found around the heads of the marshes, along ditches or in boggy situations (Ganong, 1903, pp. 439, 441); also rather commonly in similar situations along Cobequid Bay. One station, a few miles inland in the vicinity of Heatherton, Antigonish County, is found in a swampy spot marked on the geological map as a salt spring. An extensive stand of the grass just west of Annapolis Royal has been known for a long time (Fernald, 1922, p. 161). Although of no great economic value, the plant is sometimes used for a variety of purposes such as thatching and wicker or basket work. The mature panicles are highly decorative. Known around the world on all continents.

13. SCHIZACHNE Hack.

Rather tall perennial with a few-flowered, open to contracted panicle; spikelets large, several-flowered, only the lower ones producing grains; lemmas rounded on the back, distinctly-nerved, and long-awned from between the two terminal membranous teeth; callus with a ring of short hairs.

1. *Schizachne purpurascens* (Torr.) Swallen FALSE MELIC





One of the rarest native grasses of the province, found only in the extreme northern part of Cape Breton Island and at Moore's Falls near Kentville. It is tall and slender, with weak culm and soft glabrous leaves; generally found in open rocky woods or along stream banks. Of all our native grasses, this one alone is characterized by the closed sheath and sheathing ligule. The generally purplish glumes, the fringed lemma with its long straight awn and bifid tip, and the few long-pedicelled spikelets of the inflorescence, are other good features for the recognition of this species. (*Melica striata* Hitchc.) Nfld. to Alaska southward.

TRIBE II. **HORDEAE**

a. Leaves not tough and bristle-like; spikelets two-ranked forming a two-sided to cylindrical spike.

b. Spikelets occurring singly at each node of the axis, sometimes in pairs at the lower nodes.

c. Perennials; spikes slender. with spikelets 4- to 12-flowered.

d. Spikelets placed with the edges of the florets towards the axis of the spike; both glumes present.

14. *Agrcpyron* (p. 218)

d. Spikelets with the back of one row of florets towards the axis of the spike; lower glume in each spikelet absent, except in the terminal spikelet.

20. *Lolium* (p. 226)

c. Annual or winter-annual cultivated cereals; spikes denser and stouter, with the spikelets 2- to 5-flowered.

e. Glumes broad, 3-nerved; lemmas awnless or long-awned; spikelets generally 3- to 5-flowered.

15. *Triticum* (p. 221)

e Glumes narrow, bristle-like, 1-nerved; lemmas long-awned; spikelets generally 2-flowered.

16. *Secale* (p. 222)

b. Spikelets more than one at each node.

f. Spikelets two at each node of the axis, both alike.

g. Glumes well-developed; spike dense with appressed or ascending spikelets.

17. *Elymus* (p. 222)

g. Glumes obsolete, or present as slender bristles; spike very open, with spikelets spreading horizontally at maturity.

18. *Hystrix* (p. 224)

f. Spikelets 3 at a node, the lateral pair short-stalked and sometimes reduced to awns.

19. *Hordeum* (p. 225)

a. Leaves involute, tough, slender and bristle-like, arising from a tuft of whitened, hard sheaths; spikelets turned to one side forming a slender one-sided spike; glumes absent or obsolete.

21. *Nardus* (p. 227)

14. AGROPYRON Gaertn.

Tufted or rhizomatous perennials with spikelets arranged singly at each node and with the edges of the florets adjacent to the rachis; spikelets several-flowered; glumes and lemmas firm, rounded on the back and tapering into a point or awn; ligule short, tough-membranous; hooked auricles often present at top of sheath.

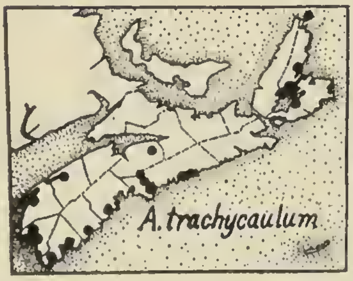
a. Spikelets breaking up readily at maturity, leaving the glumes attached to the rachis; rachilla pilose; anthers 1 to 2 mm. long; rhizomes absent.
1. *A. trachycaulum*

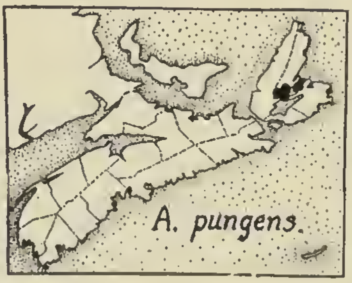
a. Spikelets not separating readily between the florets at maturity but dropping from the rachis intact with the glumes; rachilla not pilose; anthers 3 to 7 mm. long; long creeping rhizomes present.
  b. Blades firm, stiff, glabrous and glaucous, with a few broad ribs; culms completely or almost filled with pith towards the top; spike nearly square in cross-section; internodes of rachis thick and usually 4-angled.
  2. *A. pungens*

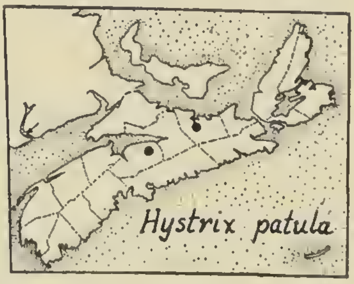
  b. Blades softer, flat, generally sparsely pilose on the upper surface, green or sometimes somewhat glaucous, with many narrow ribs; culms hollow at the top; spike not conspicuously 4-angled; internodes of rachis thin and rounded on the back.
  3. *A. repens*

1. ***Agropyron trachycaulum*** (Link) Steud.

SLENDER WHEAT-GRASS







This is a very variable species and has been studied by several different workers. The following papers may be referred to: Pease, A. S. and A. H. Moore, *Agropyron caninum* and its

Northern American allies. *Rhodora* **12**: 61-77, 1910. Malte, M. O., The so-called *Agropyron caninum* (L.) Beauv. of North America. Nat. Mus. Can., *Ann. Rpt.* 1930: 27-48, 1932. Fernald, M. L., *Agropyron*, § *Goularda* in eastern North America. *Rhodora* **35**: 161-182, 1933. Hitchcock, A. S., New species, and changes in nomenclature, of grasses of the U. S. *Amer. Jour. Bot.* **21**: 127-139, 1934. Fernald, M. L., *Agropyron trachycaulum* versus *A. pauciflorum*. *Rhodora* **36**: 417-420, 1934.

In Nova Scotia this species is represented by the following varieties, with distinguishing characteristics according to Fernald's treatment (l. c. 1933):

a. Awns wanting or very short.
  b. Glumes (excluding awns) 10 to 16 mm. averaging 12.5 mm. long; fruiting spikes narrow, 5 to 12 mm. thick.
    var. *majus*

  b. Glumes (excluding awns) 7 to 10 mm., averaging 8 mm. long; fruiting spike narrower, 3 to 6 mm. thick.
    var. *novae-angliae*

a. Awns nearly equaling to much longer than the body of the lemma.
    var. *glaucum*

Var. ***majus*** (Vasey)Fern. Found on gravelly beaches of lakes or bordering marshes in Shelburne, Yarmouth and Digby Counties, around the Bras d'Or Lakes, and on St. Paul Island. Labrador to British Columbia, south to Maine, etc. (*A. pauciflorum* (Schwein.)Hitchc. in part, of Hitchcock's Manual)

Var. ***novae-angliae*** (Scribn.)Fern. Found in a variety of habitats, along dry or gravelly beaches of brackish lakes or sea shores, gypsum talus, rocky flood plains, or turfy mats on sea cliffs. Queens, Halifax and Hants Counties and around the Bras d'Or Lakes. Labrador to British Columbia, south to Connecticut, Wisconsin, etc. (*A. pauciflorum* (Schwein.) Hitchc. in part, of Hitchcock's Manual)

Var. **glaucum** (Pease & Moore)Malte. Found in thickets, along gravelly beaches of brackish or salt shores, or dry roadsides. Shelburne, Digby, Lunenburg, Halifax Counties and around Bras d'Or Lakes. Nfld. to British Columbia, south to New England, Pennsylvania and California. (*A. subsecundum* (Link)Hitchc. in Hitchcock's Manual)

2. *Agropyron pungens* (Pers.) R. & S.

Closely related to *A. repens* as shown in its similar growth and chromosome number and sometimes growing associated with it. Found in the province only along the brackish shores of the Bras d'Or Lakes, Cape Breton Island, with specimens collected at Iona, Grand Narrows, Baddeck and George River.

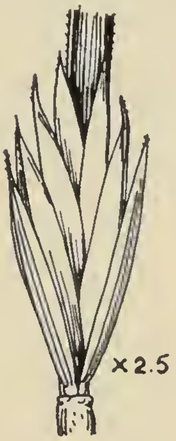
Some of the plants of this species with fewer florets (3 to 5) in the spikelets, shorter and more involute leaves, and more open inflorescence, were originally described as a separate species, *A. acadiense* by Hubbard (*Rhodora* **19**: 15-17, 1917). These characteristics, as well as others cited by Hubbard, have been found to grade into those typical of the species; and the plants have been reduced to varietal status as *A. pungens*, var. **acadiense** (F. T. Hubb.)Fern. (*Rhodora* **23**: 232, 1921). Found growing with the species. (Map p. 218)

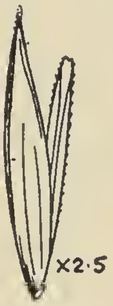
3. *Agropyron repens* (L.) Beauv.

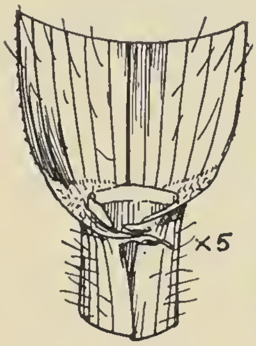
COUCH-GRASS, QUACK-GRASS

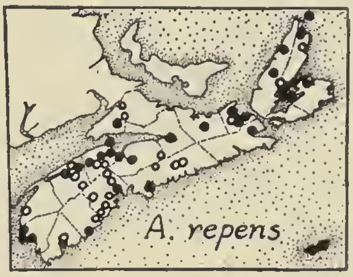
This is thought to be a native grass of coastal areas from Newfoundland and the lower St. Lawrence to New England, which has invaded fields and waste places to become a noxious weed. In cultivated land it spreads rapidly by its long, tough, underground stems and is very difficult to eradicate. In hay fields and pastures, however, the grass provides good fodder. It is also common along sand beaches, roadsides, reclaimed and brackish marshes.

The species exhibits great variability and many varieties and forms have been described. The following segregations based on characters of the flowering parts have been given by Fernald, and may be found throughout the province. Each of the eight is represented by numerous specimens collected at various sites, which show no correlation with habitat or geographical regions. Fernald, M. L., The American variations of *Agropyron repens. Rhodora* 35: 182-185, 1933.









Typical variety has the glumes oblong, rounded or abruptly narrowed at the tip, with broad scarious margins; rachis glabrous except for the ciliate edges; glumes and lemmas not definitely awned. Forma ***aristatum*** (Schum.)Holmb. differs in having the glumes and lemmas awned. Forma ***trichorrachis*** Rohlena differs in having the rachis pilose. Forma ***pilosum*** (Scribn.)Fern. has both the glumes and lemmas awned, and also the rachis pilose.

Var. ***subulatum*** (Schreb.)Reichenb. in its typical form has the glumes lanceolate, tapering gradually from near the middle to near the apex; margin narrow or inrolled; rachis glabrous except for the ciliate margins; glumes and lemmas not awned. Its forma ***Vaillantianum*** (Wulf. & Schreb.)Fern. differs in having glumes and lemmas awned. Forma ***heberhachis*** Fern. has the rachis pilose. Forma ***setiferum*** Fern. has awned glumes and lemmas, and pilose rachis.

15. TRITICUM L.

Annual or winter-annual cereal grasses with 2- to 5-flowered spikelets occurring singly at the nodes of the thick stiff spike; glumes broad, 3-nerved with the mid-nerve placed towards one side; lemmas broad, firm, smooth, awnless or long-awned; hooked auricles present at top of sheath.

1. ***Triticum aestivum*** L. COMMON WHEAT

Cultivated to some extent in the province; also found growing as an escape in farm yards, city dumps, around grain elevators, railroad stations, wharves, etc. (*T. vulgare* Vill., *T. sativum* Lam.)

16. SECALE L.

Annual or winter-annual cereal grasses with 2-flowered spikelets arranged singly at the nodes of the slender somewhat nodding spike; glumes narrow and bristle-like; lemmas broad and ciliate on the keel, long-awned; hook-like auricles sometimes present at top of sheath.

1. ***Secale cereale*** L. COMMON RYE, WINTER RYE

Cultivated, but volunteering in waste places, or in fields the year following cropping.

17. ELYMUS L.

Perennial native grasses with spikelets occurring in pairs at each node of the rachis of the spike; spikelets 2- to 6-flowered; glumes broad, or narrow and awn-like; lemmas pointed or long-awned; hook-like auricles sometimes present at the top of the sheath; ligule short and tough-membranous.

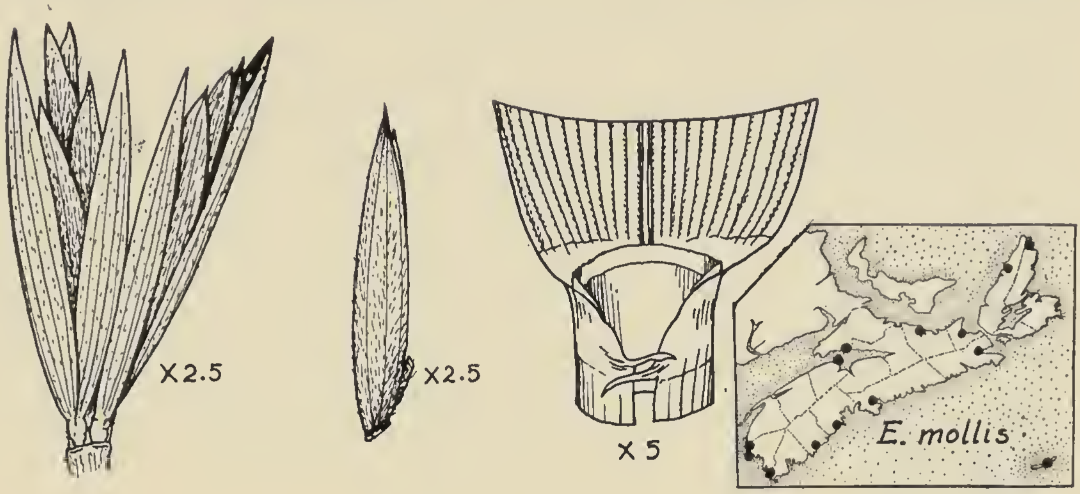
a. Glumes broad, 2 to 4 mm. wide, lanceolate, not thickened or bowed-out at the base; blades broad, coarse and glaucous; culms densely short-pubescent towards the top. Stout plants with tough rhizomes, growing only on sandy or gravelly sea beaches.

1. *E. mollis.*

a. Glumes less than 2 mm. broad, slender, stiff and long-awned, thickened and bowed-out at the base; blades thin and green, well-distributed along the culm; culms glabrous. Slender plants without underground rhizomes.

2. *E. virginicus*

1. *Elymus mollis* Trin. AMERICAN DUNE-GRASS



A coarse, broad-leaved grass found on sandy beaches all along the coast. In North America the plant was first called *E. arenarius*, var. *villosus* E. Mey. on account of its close resemblance to the European *E. arenarius* L. The plants are now considered to be specifically distinct, the European plants being glabrous on the culm and glumes, the North American plants soft pubescent (*Rhodora* 17: 98-103, 1915). The habit of growth and general appearance of *E. mollis* is very similar to American Beach-grass, *Ammophila breviligulata*, which grows in similar situations.

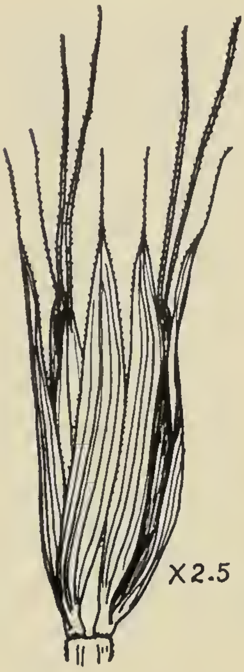
2. *Elymus virginicus* L. VIRGINIA WILD RYE, TERRELL-GRASS

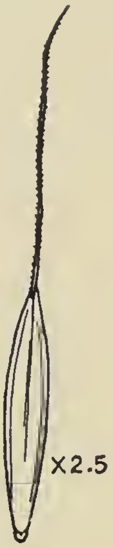
A common species showing great variability in the size, of the spikes, their exsertion above the uppermost sheath, the length of the awns and pilosity of the lemmas. Varieties and forms based on such characteristics have been classified differently by Wiegand (*Rhodora* 20: 82-84, 1918), Fernald (*Rhodora* 35: 196-198, 1933), and Hitchcock (1935). The sub-specific types likely to be found in the province are as follows:

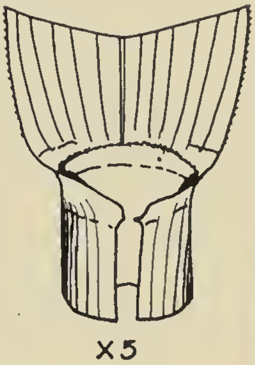
Var. ***typicus***, with its broad green blades, coarse spikes about 10 cm. long, and glabrous spikelets is found in moist or shaded places in various parts.

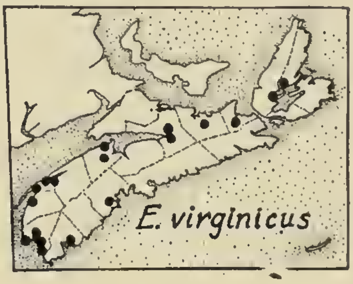
Var. **halophilus** (Bickn.)Wieg., with slender and generally inrolled blades, culms and spikes more slender, and glabrous lemmas, is known from around estuaries in Yarmouth County.

Var. **intermedius** (Vasey)Bush, with spikes and stems much as in var. *typicus* but with the lemmas, glumes and rachis hirsute: found along Sand Beach, Yarmouth; on the railroad embankment near the shore at Smith's Cove, Digby County; and at Digby. Var. *typicus*. f. *hirsutiglumis* (Scribn.)Fern. and var. *halophilus*, f. *lasiolepis* Fern. (*Rhodora* **35**: 198, 1933) are included here.









Elymus canadensis L.

The occurrence of this species, noted from Pictou (Macoun, 1888), has not been substantiated by specimens nor reported again in the province.

18. HYSTRIX Moench

Spikelets in pairs or rarely in threes at the nodes of the rachis, at maturity spreading horizontally and readily shattering; spikelets 2- to 4-flowered; glumes reduced to short bristles or obsolete; lemmas tapering into long awns generally 2 to 3 cm. long.

1. ***Hystrix patula*** Moench BOTTLE-BRUSH GRASS

A rare grass of wooded bottomlands. Collections along Five Mile River, Hants County by members of the Gray Herbarium Expedition, and in the valley of the East River at Charcoal, by St. John, are the only specimens taken to date from the province (map, p.218). They belong to var. ***Bigeloviana*** (Fern.)Deam with pilose lemmas (Fernald, M. L. The northern variety of *Asperella Hystrix*, *Rhodora* **24**: 229-231, 1922). (*Asperella Hystrix* (L.)Humb.)

19. HORDEUM L.

Spikelets arranged three at a node, sometimes only the middle spikelet develops, the two lateral and stalked spikelets remaining reduced and abortive; spikelets 1-flowered (central spikelet sometimes 2-flowered in *H. montanense*), with long-awned glumes and lemma; at maturity the rachis breaks up readily into sections, except in the cultivated barley; hook-like auricles present in some species.

a. Body of lemma about 10 mm. long; rachis not breaking up at the joints. Annual cultivated cereal.
1. *H. vulgare*

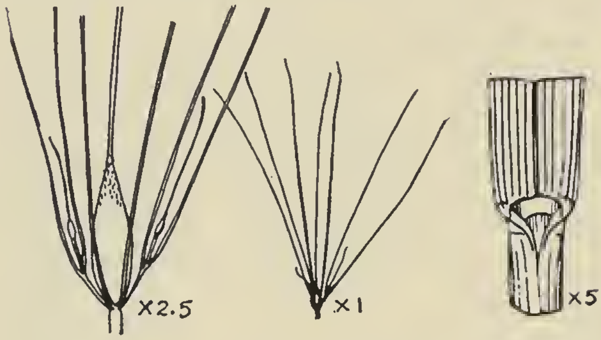
a. Body of lemma less than 8 mm. long; rachis disarticulating readily at maturity. Slender biennial or perennial grasses.
  b. Lateral spikelets abortive and represented by three awns; central spikelet 1-flowered without a prolongation of the rachilla; awns 4 to 8 cm. long.
  2. *H. jubatum*

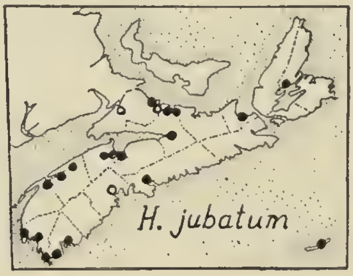
  b. Lateral spikelets well-developed; central spikelet 2-flowered, or with a reduced second floret at the tip of the rachilla; awns 1 to 4 cm. long.
  3. *H. montanense*

1. ***Hordeum vulgare*** L. CULTIVATED BARLEY

This common cereal, extensively cultivated in the province, is generally of the 6-rowed type (*H. hexastichon* L.). Tworowed barley (*H. distichon* L.) is cultivated sometimes. Found as an annual weed in dumps, waste places, farm yards, etc.

2. ***Hordeum jubatum*** L. FOX-TAIL BARLEY





A well-known weedy grass, easily recognized by its tassel-like spikes of pale green or purplish awns. Common throughout the province in pastures and around farm-yards, but especially abundant along the salt marshes and on the dykes.

3. ***Hordeum montanense*** Beal

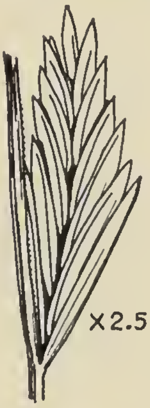
A single large colony was located in 1941 by Roland on a dyke by a brookside, Onslow, Colchester County. The plant has probably been introduced here, since its native range is in the prairies.

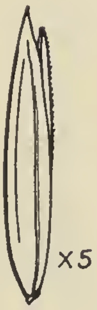
20. LOLIUM L.

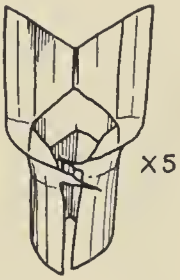
Spikelets arranged singly in a slender spike with the backs of one rank of lemmas next to the rachis, several-flowered; first glume (the one that would be adjacent to the rachis) absent; second glume generally long and exceeding the lower lemma in length; both glumes present in the terminal spikelet of the spike; auricles present; ligule thin-membranous.

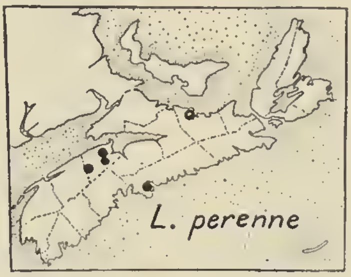
1. ***Lolium perenne*** L. PERENNIAL RYE-GRASS

A choice pasture grass in northern Europe, but not as persistent or strongly perennial in America on account of its susceptibility to winter-killing. It gives rapid growth in the first year and is sometimes used in seeding down pastures to be grazed the same season. It is also used in lawn mixtures to give a green cover soon after sowing. Found at several places in the province, particularly in new lawns sown to English seed mixtures.









Lolium temulentum L.

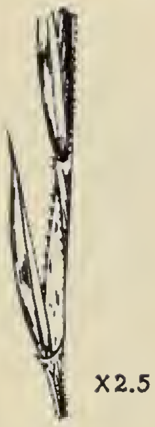
Recorded by Ganong (1903, p. 431) as a secondary species in the *Phleum-Agropyron* Association of the dyked marshes. No specimen of this plant has been seen from Nova Scotia.

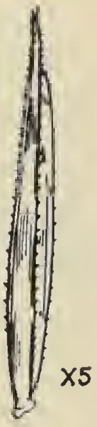
21. NARDUS L.

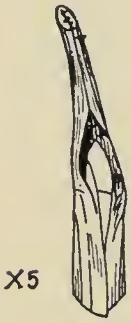
Coarse tufted perennial with slender involute wire-like leaves; spikelets one-flowered and occurring singly on the axis, twisted sideways to form a slender one-sided spike; glumes wanting, or the upper one merely a reduced scale bordering the niche in which the floret is sessile to the axis.

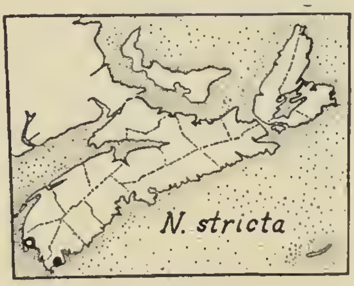
1. *Nardus stricta* L. MOOR MAT-GRASS

This grass is so coarse that it is unpalatable to animals except in the very early part of the season; and in northern Europe it has become a very extensive pest in sheep-grazing land. In North America the plant is known from a few isolated stations in Nfld., New Hampshire, New York, Massachusetts and Michigan, where it has undoubtedly been introduced. No published records are available from Canada to date although its presence in southern Quebec (Weedon, Wolfe Co., J. H. Whyte) has been known since 1936. In Nova Scotia the plant grows in an old pasture at Clyde River, Shelburne County, and probably also at Tusket, Yarmouth County.









Tribe III. AVENEAE

a. Ligule membranous; no tuft of hairs at the top of the sheath

b. Perennial grasses with spikelets less than 12 mm. long.

c. Awns absent; glumes very unequal in width, the second much broader than the first

22. *Sphenopholis* (p. 229)

c. Awns present; glumes essentially of equal width.

d. Panicle contracted, or with the branches ascending; lemmas flattened, with sharply-keeled backs; blades and sheaths finely pubescent.

e. Spikelets generally more than 2-flowered; each lemma with a slender awn.

23. *Trisetum* (p. 230)

e. Spikelets 2-flowered; only the upper lemma awned, with a short, hooked awn.

27. *Holcus* (p. 234)

d. Panicle loosely open, the spikelets on slender branches; blades and sheaths glabrous; spikelets 2-flowered.

f. Florets both perfect, and with awned lemmas; glumes equal in length; spikelets 3.0 to 5.5 mm. long; blades less than 3 mm. wide.

24. *Deschampsia* (p. 231)

f. Florets not alike, the lower staminate and long-awned, the upper perfect and not awned; second glume longer than the first; spikelets 7 to 9 mm. long; blades 5 to 10 mm. wide.

26. *Arrhenatherum* (p. 234)

b. Annual cultivated grasses with large spikelets more than 12 mm. long; lemmas awned or awnless.

25. *Avena* (p. 233)

a. Ligule a row of fine hairs; tufts of hairs present at the top of the sheath.

g. Lemma with a twisted awn arising from between the two sharp teeth.

28. *Danthonia* (p. 235)

g. Lemma awnless, with three small teeth at the apex.

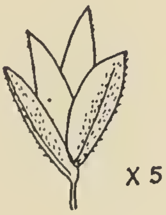
29. *Sieglingia* (p. 237)

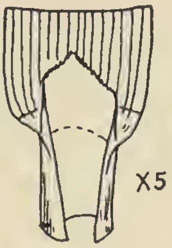
22. SPHENOPHOLIS Scribn.

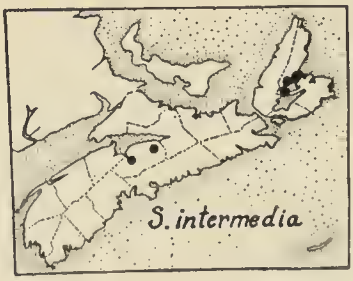
Slender grasses with nodding, more or less contracted panicles of small shining spikelets; panicle branches spikelet-bearing from the base; spikelets generally 2-flowered, falling away entire due to the articulation below the glumes; leaf-blades flat, 2 to 6 mm. wide, mostly glabrous.

1. ***Sphenopholis intermedia*** (Rydb.) Rydb.

SLENDER WEDGE-GRASS







First reported by Fernald in 1921 as *S. pallens* (Spreng.) Scribn., the name then erroneously ascribed to this grass.

True *S. pallens* is now known to be an awned form restricted to rare occurrences in South Carolina and Virginia; while all the Nova Scotian plants belong to the transcontinental *S. intermedia.* This has been collected at but five separate sites in the province, in every case growing on cliff-faces or in gravel situations where its roots were in contact with limestone or gypsum. Nfld. to British Columbia, south to Florida.

23. TRISETUM Pers.

Tufted perennial grasses with the spikelets 2- to 5-flowered in dense to merely contracted panicles; glumes about equal in width, the upper one nearly as long as the first lemma, longer than any floret; lemmas awned from the back, sharply keeled, with two slender teeth at the apex; rachilla and generally the callus of the lemma with short hairs; sheaths rather hairy.

a. Panicle dense and spike-like; spikelets generally greenish; awns nearly straight, not twisted.
  b. Glumes glabrous except for the ciliolate keels.
    1. *T. spicatum*, var. *molle*
  b. Glumes pubescent.
    1a. *T. spicatum*, var. *pilosiglume*
a. Panicle looser and somewhat open; spikelets tinged with brown or purple; awns long and strongly twisted.
    2. *T. flavescens*

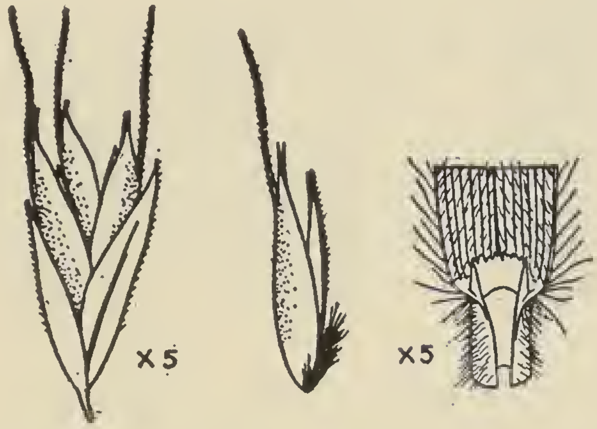
1. ***Trisetum spicatum*** (L.) Richter SPIKE TRISETUM

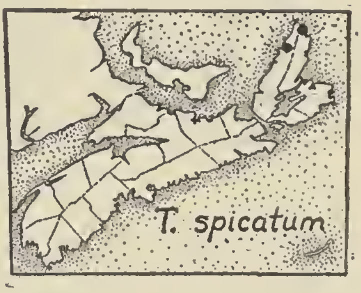
Two varieties of this species have been found in the province only at the northern tip of Cape Breton Island.

Var. ***molle*** (Michx.) Beal, which is generally distributed across Arctic and temperate North America, is found along the Cheticamp River.

Var. ***pilosiglume*** Fern. (*Rhodora* **18**: 195-198, 1916) has affinities with the flora of regions to the north of N. S., of

Newfoundland, Gaspé, and certain high mountains of Maine and New Hampshire. Found along the Cheticamp River and scattered on rocky outcrops along some of the streams of Bay St. Lawrence.





2. ***Trisetum flavescens*** (L.) Beauv. GOLDEN OAT-GRASS

An introduced forage grass found persisting in old pastures in the town of Meteghan, Digby County.

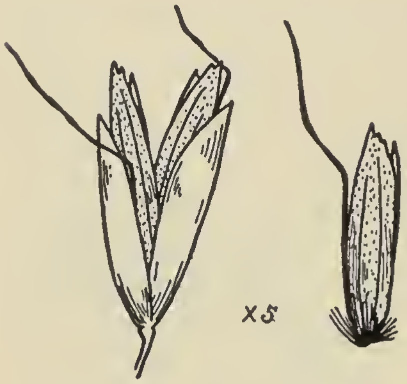
24. DESCHAMPSIA Beauv.

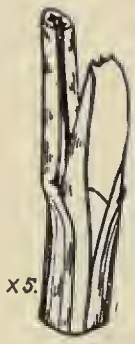
Narrow-leaved perennials, with open panicle of widely-spreading delicate branches; spikelets 2-flowered; glumes broad, acute and about equal in size; lemmas toothed at the apex, with a slender awn arising from near the base; callus of the lemma, and the rachilla with straight hairs; ligule membranous; foliage glabrous.

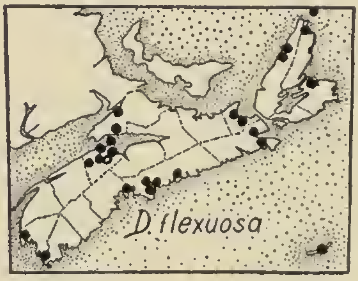
a. Leaves filiform, involute, less than 1 mm. in diameter; awns twisted, extending well beyond the glumes; lemmas and sheaths scabrous.
1. *D. flexuosa*

a. Leaves flat or folded, 1 to 3 mm. broad; awns straight, not much longer than the lemmas, not conspicuously exserted; lemmas and sheaths glabrous.
2. *D. caespitosa*

1. **Deschampsia flexuosa** (L.) Trin. CRINKLED HAIR-GRASS



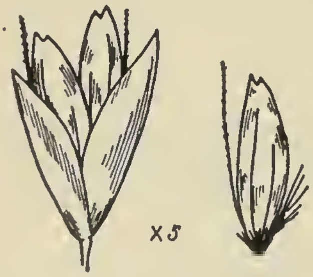


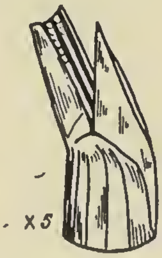


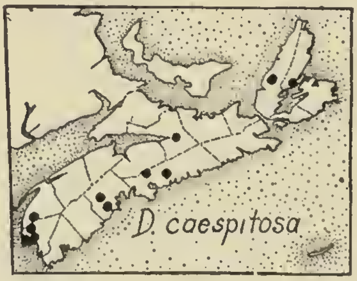
Common throughout the province, in dry barren soils, such as on the tops of exposed granitic hills, on sandy plains in Kings and Annapolis Counties, sea-cliffs, and barren headlands. It is readily recognized in the field by its basal tuft of very fine leaves, and the shining silver and purplish spikelets at the tips of the very fine, spreading panicle-branches.

A northern variation of this plant (var. *montana*) with slightly larger spikelets has been reported (Perry, 1931) from St. Paul Island off the tip of Cape Breton. This variation, however, does not seem to be distinct. Both our species of *Deschampsia* exhibit great variation in their stature, size and shape of leaves, panicles, spikelets, etc., and are decidedly polymorphous. Greenland to Alaska southward; Eurasia.

2. **Deschampsia caespitosa** (L.) Beauv. TUFTED HAIR-GRASS







A taller species than the preceding, up to 7.5 dm. high, with the slender branches of the large open panicle tipped with purplish, silvery, shining spikelets, 3.5 to 5.0 mm. long.

The common variety in Nova Scotia is var. **glauca** (Hartm.) Lindm. (*Rhodora* 28: 152, 1926), smaller in height and in size of spikelets, leaves, ligules, etc., than the typical European plants on which the species description was based.

Rather rare in the province, growing on riverbanks in moist rocky soil, on lake shores, and in damp soil in various places from Yarmouth to Cape Breton. Greenland to Alaska southward.

25. AVENA L.

Annual grasses with broad leaves and large spreading panicle; spikelets large, 2- or 3-flowered, usually pendulous; lemmas awnless or with a large twisted and geniculate awn inserted about the middle of the back, hard and tough and enclosing the grain; rachilla, and sometimes the back of the lemma, hairy; auricles absent; ligule membranous, long and whitish.

a. Lemmas glabrous; awns entirely absent, or, if present, not twisted or twisted but a few times at the base; florets not readily separating from the spikelet nor from each other.
1. *A. sativa*

a. Lemmas with long, slender and twisted hairs on the back, and a ring of stiff, brown, bristle-like hairs from around the callus; awns strong and stiff, the lower part twisted and extending beyond the tip of the lemma, upper part about twice as long as the lower part; florets readily separating from the spikelet.
2. *A. fatua*

1. ***Avena sativa*** L. CULTIVATED OAT

A common cereal plant grown extensively in the province for grain or for green fodder; frequently found as an escape.

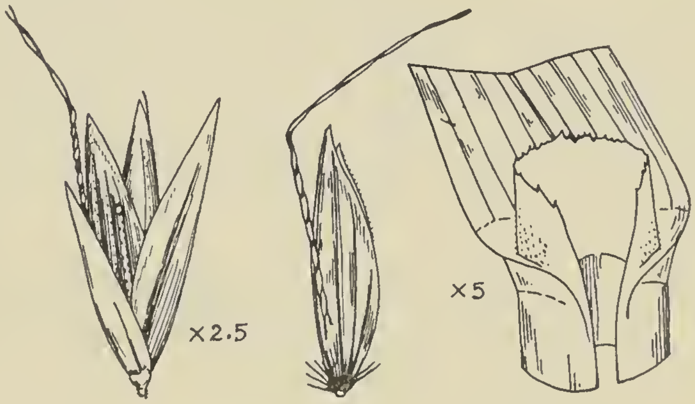
2. ***Avena fatua*** L. WILD OAT

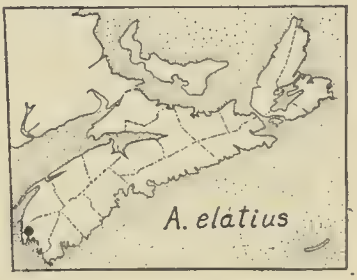
Very similar to the cultivated oat in appearance. Sometimes found as a weed in fields of cultivated oats, arising from impurities in seed, or in waste places around farms or towns.

26. ARRHENATHERUM Beauv.

Tall perennial grass with slender open panicle; spikelets 2-flowered, the lower floret with stamens only and bearing a long twisted and geniculate awn from the back of the lemma near its base, the upper being perfect and producing a grain, almost awnless; upper glume longer than the lower and equalling the spikelet in length; lemma with stiff hairs on the callus; ligule long and membranous.

1. *Arrhenatherum elatius* (L.) Presl. TALL OAT-GRASS



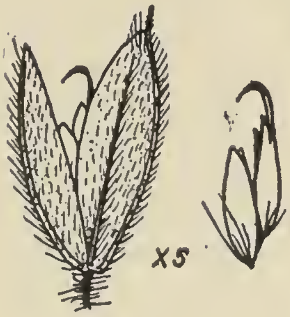


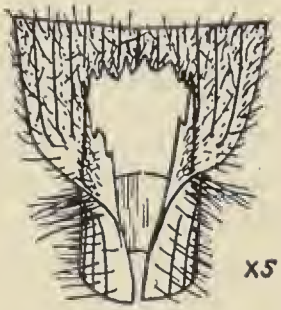
A valuable forage grass for hay crops on heavy land, but not commonly used for this purpose in the province. It was found in 1940 well established around the edges of a field at an Illustration Farm in Yarmouth County. Introduced from Europe, and escaped from cultivation.

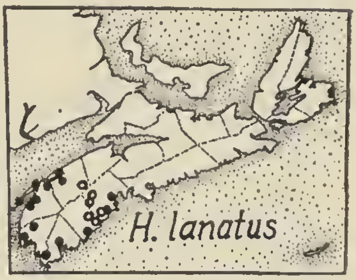
27. HOLCUS L.

Velvety pubescent, perennial grass with contracted dense panicles of whitish, pink or purplish spikelets; spikelets falling away entire at maturity, 2-flowered, the lower floret with both stamens and ovulary, the upper with stamens only; glumes broad and enclosing the whole spikelet; lemmas firm and smooth, the lower awnless, the upper with a short, sharp, hooked awn. (*Nothoholcus* Nash)

1. ***Holcus lanatus*** L. VELVET-GRASS, YORKSHIRE FOG







A conspicuous and readily recognized grass on account of its striking pale or purplish appearance and soft felted pubescence. The production of inflorescences shows no marked periodicity; and in mid-season, panicles in all stages of development may be found on the same plant.

One of the most abundant grasses throughout Shelburne, Yarmouth and Digby Counties in meadows, pastures, roadsides and waste places. On some farms this is considered to be a valuable forage species, and passes under various erroneous names, of which Orchard Grass is the commonest. In Europe the grass is not classed as a highly palatable species on account of its fuzziness. Although the grass has been thoroughly established and has grown throughout south-western Nova Scotia for a long time, it has not spread to the eastern parts of the province.

Numerous varieties have been proposed by European workers based on the colour and pubescence of the various parts, but these do not seem important enough in our material to warrant separate recognition. Introduced from Europe; also abundant in southern coastal British Columbia, but not well established elsewhere in Canada.

28. DANTHONIA Lam. & DC.

Tufted perennial grasses with compact or spreading panicles composed of few spikelets on stiff branches; spikelets 3- to 8-flowered, enclosed by the glumes which persist on the branches after the shedding of the florets; lemmas firm, rounded on the back, sharply 2-toothed at the apex and bearing a long twisted awn from the back between the teeth, sparsely pilose on the back and with short straight hairs from the callus.

a. Basal leaf-blades usually less than 15 cm. long, curled when dead and dry; ligule a row of short hairs less than 1 mm. long at the center, but 2 to 3 mm. long at the edges; sheaths, at least the lower ones, spreading-pilose; blades with sparse pilose hairs, rarely glabrous on both sides; teeth of the lemma sharply acute but without long slender points, generally less than 2 mm. long; branches of the panicle ascending, excepting during anthesis, giving a spike-like appearance.

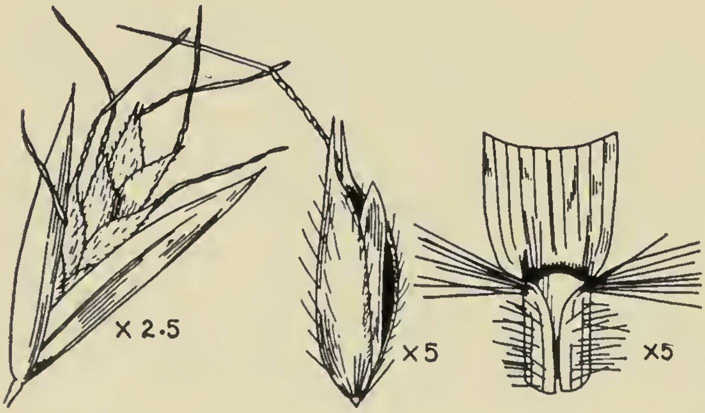
1. *D. spicata*

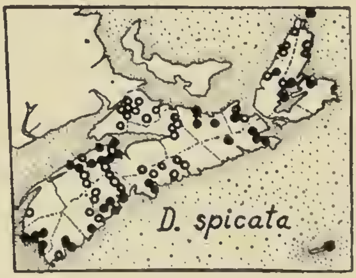
a. Basal leaf-blades 15 to 50 cm., averaging 30 cm. long, not curling greatly when dead and dry; ligule of long silky hairs, 3 to 6 mm. long; sheaths, except for the tuft of hairs at the throat, and blades glabrous; teeth of the lemma slender and awn-like, membranous, sometimes slightly twisted, 2 mm. or longer; lower branches of the panicle spreading, and generally reflexed during and after anthesis.

2. *D. compressa*

1. ***Danthonia spicata*** (L.) Beauv.

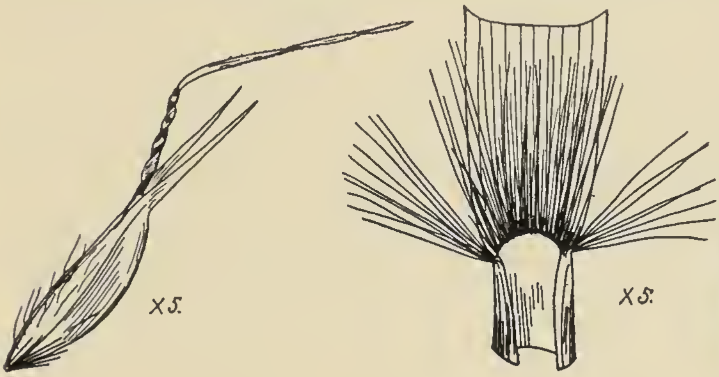
POVERTY-GRASS, WIRE-GRASS, WILD OAT-GRASS

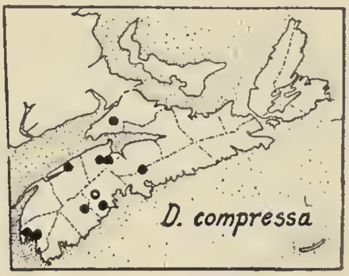




One of our most abundant grasses, found everywhere on poor or sterile soil. Depleted pastures have a matted covering of this species, worthless for grazing. The curled basal leaves persist from year to year, and make a tuft of coarse dry material that pulls up readily by the roots and is decidedly unpalatable to stock. The plant is readily replaced by better grasses when pasture improvement is carried out; but it quickly becomes dominant again as soon as the land is neglected. It shows considerable variation in stature, pubescence of leaves, and other characters; and is probably reproduced mainly by the closed-fertilized grains that are borne inside the sheaths, especially at the base of the culms. Nfld. to British Columbia, south to Florida.

2. ***Danthonia compressa*** Austin FLATTENED WILD OAT-GRASS





Rather rare in the province, found in thickets, borders of woods, along woodland paths, generally in moister soils than the preceding, and often difficult to distinguish from luxuriant specimens of it. N. S. to Quebec, south to North Carolina.

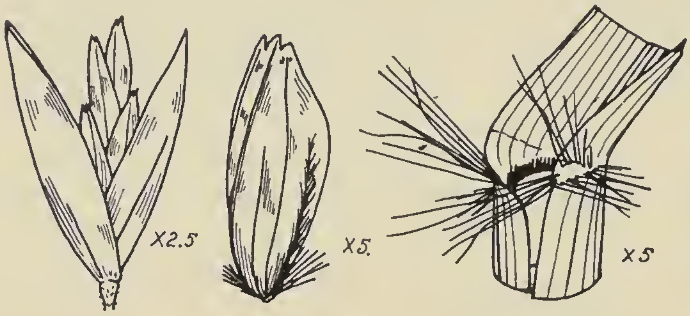
A stout erect plant, with a narrow spike-like panicle, possibly an autumnal phase of *D. compressa*, has been named *Danthonia Faxoni* Austin. Its status is still debatable. Common in southeastern Canada and the eastern States; collected on a Bay of Fundy headland, Central Grove, Digby County.

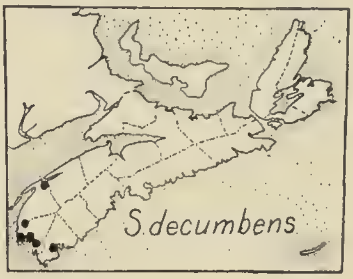
29. SIEGLINGIA Bernh.

Low, perennial, tufted grass with contracted panicles and few spikelets; culms often spreading; leaf-blades 2 to 3 mm. wide, gradually tapering to the tip; spikelets 3- to 5-flowered, enclosed by the glumes; lemmas awnless, rounded on the back, 3-toothed at the summit, with marginal and callus hairs.

1. *Sieglingia decumbens* (L.) Bernh.

MOUNTAIN HEATH-GRASS HEATHER-GRASS





Rather common in old pastures, peaty swales, and moist soils in Yarmouth and Shelburne Counties; found also at Digby. A common species of the upland heaths in Europe. Has been considered native, but is undoubtedly introduced from Europe. Nfld. and N. S. (*Triodia decumbens* Beauv.)

Closely related to *Danthonia* which it resembles in many vegetative and reproductive characters. It bears basal cleistogamous flowers in the same way, and crosses with some species of that genus (Beddows, A. R., *Ann. Bot.* **XLV:** 443-451, 1931).

TRIBE IV. AGROSTIDEAE

a. Lemma as thin or thinner than the glumes; spikelets laterally compressed or subterete.
  b. Spikelets, exclusive of the awns, 1 to 7 mm. long.
    c. Inflorescence an open or contracted panicle, if very contracted and spike-like, more or less interrupted.
      d. Spikelet disarticulating above the glumes, the empty glumes remaining on the branches after maturity; floret (not spikelet) not stalked; palea 2-nerved; stamens 3.
        e. Callus of floret with a tuft of fine hairs at least one-fourth as long as the lemma; rachilla hairy, prolonged behind the palea; second glume 3-nerved.
30. *Calamagrostis* (p. 240)

e. Callus of floret glabrous or with very short hairs; rachilla not prolonged; second glume 1-nerved.

f. Perennials; blades glabrous; ligule membranous.

g. Rhizomes not short and scaly (underground rhizomes, or long leafy stolons may be present); glumes equal or longer than the lemma, not awn-tipped; lemma awnless or awned from the back.

32. *Agrostis* (p. 243)

g. Rhizomes short, shallow, branching, scaly and knotty (absent in *M. uniflora*); body of glumes shorter than the lemma, the long-awned tip, if present, surpassing the lemma.

36. *Muhlenbergia* (p. 254)

f. Annuals; margin of blade long-ciliate; ligule a row of short hairs.

37. *Sporobolus* (p. 256)

d. Spikelet disarticulating below the glumes, falling away entire; floret short-stalked; palea appearing 1-nerved; stamen 1.

33. *Cinna* (p. 250)

c. Inflorescence a dense, cylindrical spike-like panicle with the spikelets on very short stalks.

h. Inflorescence soft to the touch; glumes not long-pointed; lemmas awned from the back, the awns often conspicuous.

34. *Alopecurus* (p. 251)

h. Inflorescence harsh to the touch; glumes long-pointed; lemmas awnless.

35. *Phleum* (p. 254)

b. Spikelets, exclusive of the awns, 8 mm. or more long.

i. Lemma awnless or very short-awned; glumes as long as the lemma; panicle densely-flowered and spike-like; sandy sea-shores and dunes.

31. *Ammophila* (p. 242)

i. Lemma tapering into a long awn; glumes minute or wanting; panicle lax with a few early-deciduous spikelets; damp woodlands.

38. *Brachyleytrum* (p. 257)

a. Lemmas thicker and firmer than the glumes, hard and shining, firmly enclosing the palea and grain; spikelets dorsally compressed or terete.

j. Lemma awnless, glabrous, smooth; spikelets dorsally compressed; culms tall, in patches from spreading rhizomes.

39. *Milium* (p. 258)

j. Lemma awned but the awn deciduous, pubescent at the base and generally over much of the back; spikelet almost terete; culms tufted, with fibrous roots.

40. *Oryzopsis* (p. 258)

30. CALAMAGROSTIS Adans.

Tall perennial grasses with many spikelets in the panicle; spikelets 1-flowered; rachilla prolonged above the floret and bearing hairs; lemma with an awn arising from the mid-rib well below the apex; callus of lemma with a tuft of hairs; ligule long and membranous.

a. Awn straight; callus hairs abundant and about as long as the lemma; lemma thin and transparent.

b. Panicle loose and open, particularly at flowering time.

1. *C. canadensis*

b. Panicle more or less contracted.

c. Blades flat, rather lax; spikelets 6 to 7 mm. long; hairs on the rachilla at the top only.

2. *C. cinnoides*

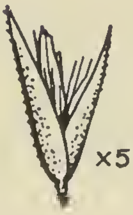
c. Blades involute, or, if flat, rigid and becoming involute; spikelets 3 to 4 mm. long; rachilla with hairs all along its length.

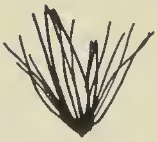
3. *C. neglecta*

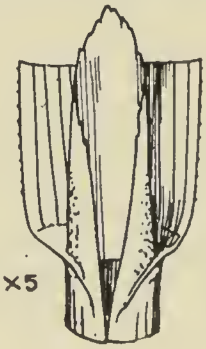
a. Awn slightly twisted, curved so that the tip sticks out from between the glumes: callus hairs scant and short; lemma firm and scabrous.

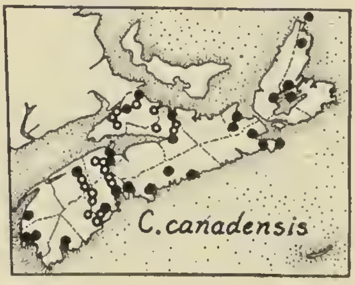
4. *C. Pickeringii*

1. ***Calamagrostis canadensis*** (Michx.) Nutt. BLUE-JOINT









A common grass of ditches, swales and fresh-water marshes throughout the province. The size of the spikelets has been taken as the basis for the segregation of several varieties but this variation does not seem to be discontinuous and is not correlated with other morphological characteristics. There is, moreover, some disagreement as to the limits of each variety among the authors of the following papers: Inman, O. L., *Calamagrostis candensis* and related species. *Rhodora* **24**: 142-144, 1922. Stebbins, G. L., A revision of some North American species of *Calamagrostis*. *Rhodora* **32**: 35-57, 1930. Muenscher, W. C. and R. T. Clausen, in Notes on the Flora of Northern New York. *Rhodora* **36**: 406, 1934. It seems best to consider the varieties as intergrading components of a highly polymorphous species.

Var. ***typica*** spikelets 2.8 to 3.8 mm. long. Common in the province, many of the plants having spikelets ranging from 3.5 to 4.0 mm. long within the same panicle and grading into the next.

Var. ***robusta*** Vasey: spikelets 3.5 to 4.5 mm. long. Common throughout. Specimens named var. *Langsdorfii* Trin., collected at Whycocomagh by Macoun in 1883 and at Boylston by Hamilton in 1890 are found to fall under var. *robusta*. True C. *Langsdorfii*, as now understood, is confined to sub-arctic regions and is not found in N. S. Specimens which might be classed definitely as var. *scabra* (Presl)Hitchc. (*Amer. Jour. Bot.* **21**: 135, 1934), with spikelets 4.5 to 6.0 mm. long and scabrous glumes, have not been found in the province.

2. ***Calamagrostis cinnoides*** (Muhl.) Barton

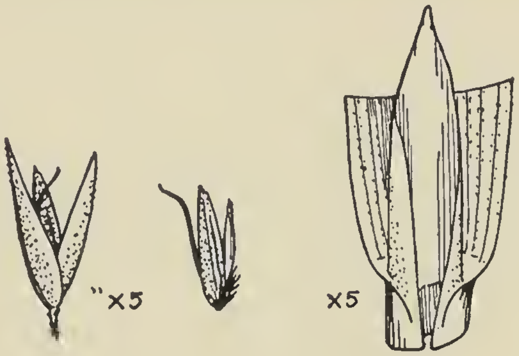
There is but one report in the literature (Stebbins, l. c.) of a collection of this species: at Halifax, by Lunt, 1912. (*C. coarctata* Torr.). N. S. and Maine, southward.

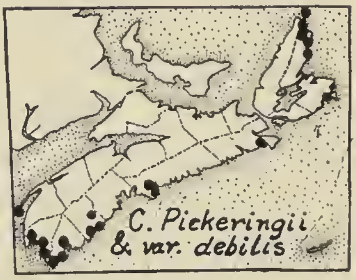
3. ***Calamagrostis neglecta*** (Ehrh.) Gaertn., Meyer & Scherb.

Collected only in the vicinity of Amherst in bogs, but reported as becoming common northward into eastern New

Brunswick, P. E. I. and Magdalen Islands (Fernald, 1921, p. 230).

4. *Calamagrostis Pickeringii* Gray





Since the publication in Macoun's Catalogue (1888) of, "the only known station for the species in Canada is in the wet meadows surrounding Louisburg, C. B., 1883," the plant has been found at numerous additional stations at widely separated points in the province, mainly along the Atlantic sea-coast regions. Found in bogs, boggy barrens, swales, and heathy meadows in the highlands.

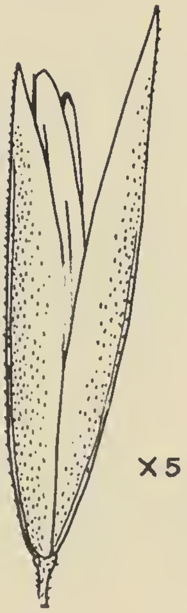
Var. ***debilis*** (Kearney)Fern. & Wieg. has shorter spikelets (2.8 to 3.6 mm. long) than has the typical species (4.0 to 5.0 mm.); much more common in similar habitats in the Atlantic tier of counties from Yarmouth to Cape North.

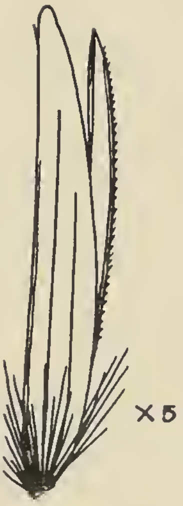
31. AMMOPHILA Host

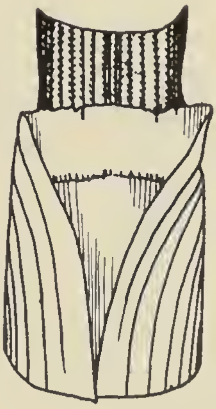
Coarse perennials with scaly rhizomes and dense spike-like, pale-colored panicles 20 to 40 cm. long; spikelets one-flowered, compressed, about 1 cm. long; lemmas glabrous except for the dense tuft of short straight hairs from the callus.

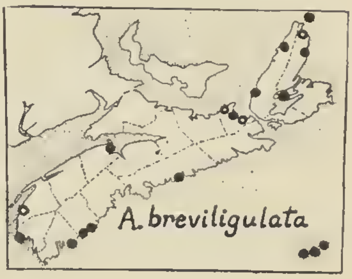
1. *Ammophila breviligulata* Fern. AMERICAN BEACH-GRASS

A coarse grass 2 to 5 feet high, with the blades tough, tapering to a long point, and readily becoming involute. Common around the shores of the province wherever sandy beaches or low dunes occur; frequently growing with the two other similar rhizomatous grasses, *Elymus mollis* and *Agropyron repens.*









It is said that the wild ponies on Sable Island subsist throughout the year mainly on this grass (St. John, 1921).

This grass is considered to be distinct from the European *A. arenaria* (L.) Link because of its shorter ligule and shorter callus hairs (Fernald, M. L. *Rhodora* **22**: 71, 1920). Along the coast from Nfld. to North Carolina, and around the Great Lakes.

32. AGROSTIS L.

Perennial grasses spreading extensively by rhizomes or stolons, but sometimes tufted; spikelets one-flowered; glumes almost equal, keeled, longer than the floret; lemmas thin-membranous, glabrous or sometimes minutely scabrous, or with minute hairs arising at the sides of the callus; palea membranous, 2-nerved, half the length of the lemma, or shorter, or absent. Malte, M. O., The commercial bent grasses (*Agrostis*) in Canada. *Nat. Mus. Can. Bull.* 50, *Ann. Rpt.* 1926: 105-126, 1928. Philipson, W. R., A revision of the

British species of the genus *Agrostis* Linn. *Linn. Soc. Journ. Bot.* **LI**: 73-151, 1937.

a. Palea obsolete or absent; panicle-branches slender or capillary; rhizomes absent.

  b. Panicle diffuse, the capillary branches re-branching at or above the middle.

  1. *A. scabra*

  b. Panicle not diffuse, or the branches re-branching below the middle.

    c. Panicle somewhat lax; several culm-leaves present; lemmas awnless, or rarely with a straight short awn; culms upright from the base; stolons absent.

    2. *A. perennans*

    c. Panicle branches more rigidly spreading; leaves mainly in a basal tuft; lemmas with a twisted geniculate, but sometimes straight and short, awn; stolons and basal decumbent part of the culm rooting at the nodes.

    3. *A. canina*

a. Palea at least one-third as long as the lemma; panicle-branches more rigid; rhizomes or stolons present.

  d. Ligule longer than broad, generally 2 to 4 mm. long on the lower leaves, frequently whitish and translucent, membranous, rounded or pointed at the apex; spikelets on short branchlets, numerous towards the axis of the panicle, the branchlets appressed or ascending after anthesis.

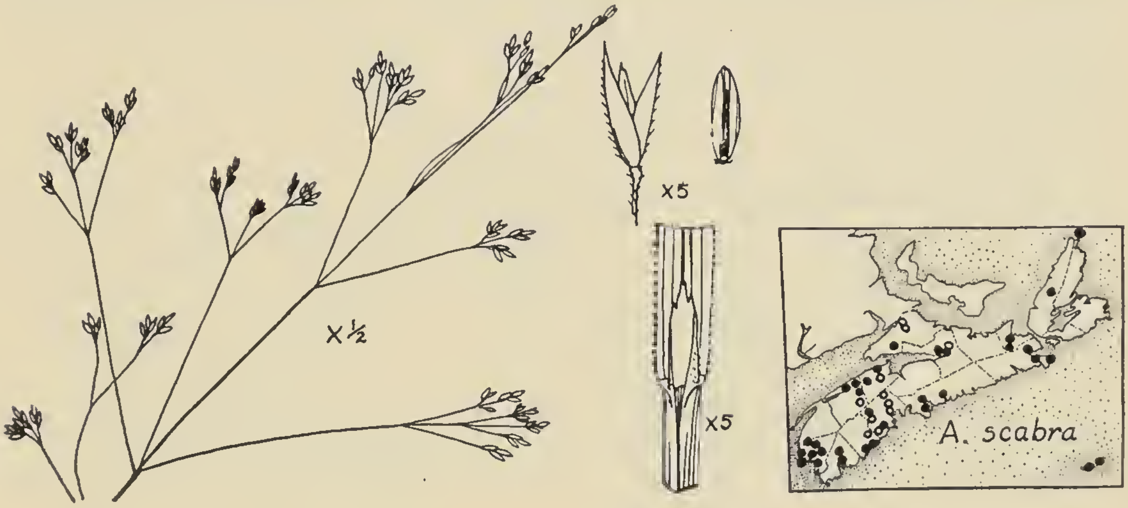
  4. *A. stolonifera*

  d. Ligule broader than long, generally 0.5 to 1.0 mm. long on the lower leaves, transparent, brownish or somewhat hyaline, truncate; spikelets not more crowded at the base of the branches, the branches divaricate-spreading after anthesis.

  5. *A. tenuis*

1. *Agrostis scabra* Willd. TICKLE-GRASS, HAIR-GRASS

The uncertain distinctness of this grass and its relationship to other species has resulted in great confusion in the past records. The species was shown by Fernald (*Rhodora* **35**: 208, 1933) to be distinct from *A. hiemalis* (Walt.) B.S.P., which does not range as far north as Nova Scotia, but with which our plants were classified for a long time. The following varieties and forms are common, or may be expected to occur in the province.



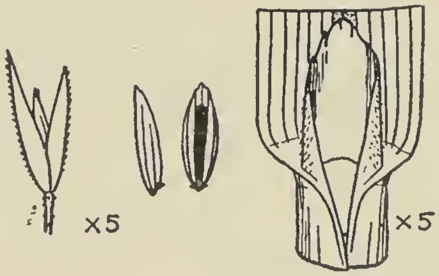
The ***typical*** variety has spikelets 2.0 to 3.0 mm. and lemmas 1.3 to 2.0 mm. long. This is a weedy plant common throughout the province in a variety of soils, but particularly in places that have been laid bare by cultivation, burning, flooding, etc. Forma ***Tuckermani*** Fern., with awned lemmas, is said to occur rarely throughout the range of the typical awnless plants from Nfld to New England, but most of the Nova Scotian specimens at hand show the lemmas awnless.

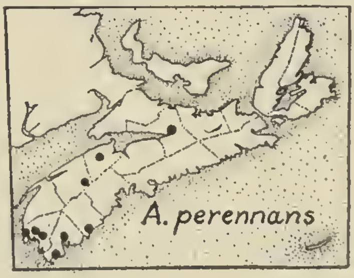
Var. ***septentrionalis*** Fern. has spikelets 3.2 to 4.3 mm. long with the lemmas 2.0 to 2.5 mm. long. Found at many places in the province, especially in the southern and southwestern areas. This has been confused with the southern coastal-plain *A. elata* and reported under the name *A. hiemalis* var. *elata* (Fernald, 1921). Forma ***setigera*** Fern., with awned lemmas, is reported from St. Paul Island, Canso and Markland (*Rhodora* **35**: 210, 1933).

Var. ***geminata*** (Trin.) Swallen (*Proc. Biol. Soc. Wash.* **54**: 45, 1941) has the mature panicles much smaller and more regularly ovoid than has typical *A. scabra*, forming one-sixth to rarely one-half the length of the plant, their branches stiffer and shorter and scarcely swollen at the base. This variety, which is typically awned, is also found with awnless lemmas (*A. geminata*, f. *exaristata* Fern. *Rhodora* 35: 211, 1933). It may range into Nova Scotia, but is not definitely known.

2. ***Agrostis perennans*** (Walt.) Tuckerm.

AUTUMN BENT-GRASS, THIN-GRASS

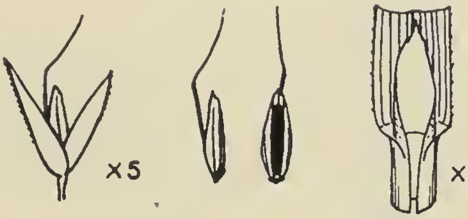


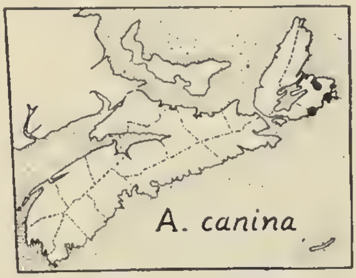


Not as abundant as the preceding species, but probably common throughout in woodlands, thickets, moist roadsides, lake margins and along the banks of streams. Considerable variation occurs, the typical plant having smaller panicles with appressed-ascending branches and spikelets on short pedicels, many shorter than the spikelets. Our plants seem to resemble more closely the woodland variety with a more diffuse panicle and spikelets on longer, more divergent pedicels, which has been named var. **aestivalis** Vasey (*A. Schweinitzii* Trin.). Awned plants of both varieties have been given formal names (*Rhodora* 35: 317, 1933), but these have not been seen from the province. N. S. to Minnesota, south to Florida.

3. ***Agrostis canina*** L. VELVET BENT-GRASS

Rare in the wild state and known only from Sydney, Louisburg and Forchu in Cape Breton, where it is well established and undoubtedly introduced from Europe. Some consider it indigenous in Newfoundland (*Rhodora* 28: 161, 1926). On account of its dense growth of fine, bright-green basal leaves, it has excellent turf-making qualities. Certain strains are used extensively for golf greens and may be found throughout the province in these special situations. Such strains, selected for active vegetative growth, are poor seed-setters and are propagated by stolons which root readily at the nodes.

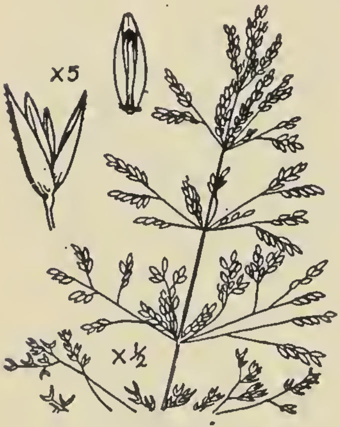




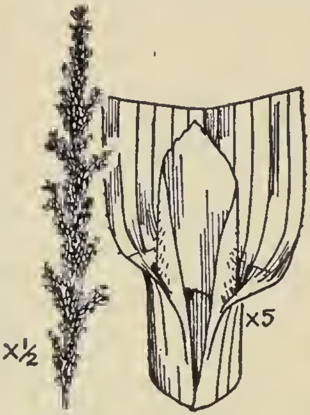
All of our plants are probably the variety *fascicularis* (Curtis) Sinclair according to the treatment of Philipson. The plants with clusters of short leaves arising from the nodes of the stolons have been described by Rousseau (*Contrib. Univ. Montr.* **32**: 17, 56, 1938) as forma *fasciculata* of the species based on plants from Forchu. This is undoubtedly an autumnal phase of the above variety. Plants that have the lemmas awnless, or occasionally with a short awn in some of the spikelets, have been collected at Louisburg, growing with the typically long-awned plants. This is probably the same as var. *mutica* Gaud., referred to by Malte as collected by Fernald and Wiegand in Newfoundland. At best it should be another form of var. *fascicularis*. Philipson places var. *mutica* among his "minor variations" which have something less than varietal rank.

4. ***Agrostis stolonifera*** L.

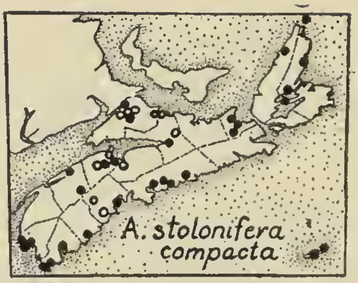
The plants typical of this species are rather obscure and of uncertain definition. It is best known by two markedly different varieties which represent the extremes in variation in a large series of intergrading types, and which are treated by some workers as distinct species. The excellent study made by Dr. M. O. Malte is followed here.



var. major



var. compacta



Var. ***major*** (Gaud.) Farw. RED-TOP

In this the panicles are open during and after anthesis; rhizomes present. Not nearly as common as var. *compacta*, but found along roadsides and in waste lots, or persisting for a short while after sowing in well-drained soil, particularly in the Annapolis Valley. It does not grow abundantly, however, as it does in Quebec and Ontario and in the northeastern States. A valuable hay and pasture species. (*A. alba* L. in Hitchcock's Manual, *A. gigantea* Roth according to Philipson)

Var. ***compacta*** Hartm. CREEPING BENT-GRASS

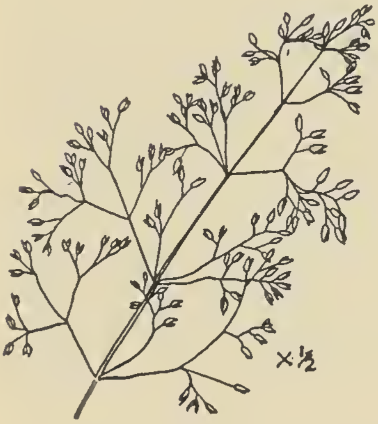
Panicles open only during anthesis, the shorter branches becoming erect and appressed into a compact panicle at maturity; stolons, spreading extensively on the surface, present.

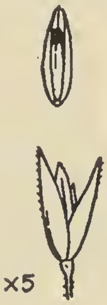
Common in moist fields and pastures, in ditches, on the upper part of salt and brackish marshes, as well as in fresh-water marshes and swales; also found along the margins of pools and streams, the stolons sometimes growing out into the water. The plant provides some forage for stock. It may become a valuable component of lawns and perhaps greens.

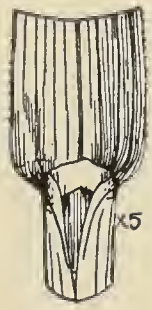
(*A. palustris* Huds. in part; *A. stolonifera* L., vars. *stolonifera* (L.)Koch and *palustris* (Huds.)Farw.)

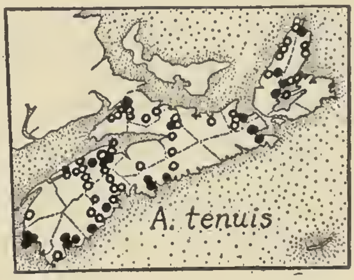
This plant shows great variation in its habit of growth, length of stolons, form of panicle, colour of the spikelets, and other characteristics. On exposed sand and gravel-flats along the sea-shore somewhat dwarfed plants with broad and short (about 1.8 mm. long) glumes and short leaves with purplish sheaths, classed by Philipson as "ecas" *arenaria* (Jenson & Wachter)Philipson, have been found at Clam Harbour, Port Mouton, Iona, Cheticamp, and Yarmouth. (*A. maritima* Lam., *A. coarctata* Ehrh).

5. ***Agrostis tenuis*** Sibth. BROWN-TOP, COLONIAL BENT-GRASS, P.E.I. BENT-GRASS, RHODE ISLAND BENT-GRASS









The most abundant and important grass species in the province, making up the majority of the cover in pastures, meadows and lawns. It is a plant naturally suited to maritime and cool humid climates and found in such regions in various parts of the world: in the upland pastures and fields in Britain and northern Europe, in New Zealand, in the north-eastern States and the Maritime Provinces. Going westward in Canada it tends to run out in Quebec in the lowlands about Quebec city and in the uplands about the Champlain valley; in Ontario it does not persist well, even after seeding, but on south-eastern Vancouver Island it again becomes abundant.

All our plants are var. *hispida* (Willd.)Philipson, according to a recent treatment (Philipson, p. 86).

Forma **aristata** (Parnell)Wieg., with most of the lemmas awned, has been found at Purcell's Cove, Halifax (Howe & Lang) and at Lawrencetown, Halifax County by M. S. Brown. This is var. *aristata* (Hartm.)Holmb. in Malte's treatment.

Plants with enlarged floral parts due to infection with the nematode *Anguillina agrostis* are abundantly found in Yarmouth, Annapolis and Kings Counties. In the past, these diseased plants have been given a separate varietal name, var. *sylvatica* (Huds.)With. (Philipson, W. R., *Jour. Bot.* **LXXIII**: 65-74, 1935).

The distinctions between Brown-top (*A. tenuis*) and Red-top (*A. stolonifera*, var. *major*) have not always been clear to field workers. Although the spikelets and some general features are similar in the two plants, there are several very striking differences. The panicle of Brown-top is smaller, looser and more open, with the fewer spikelets placed nearer the ends of the widely divergent branchlets. The shape and length of the ligules, as given in the key, are the best characteristics to separate plants in the vegetative condition; but the narrower, brighter-green and somewhat shiney-backed blades of Brown-top are also distinctive. The rhizomes of Brown-top lack the extensive underground creeping habit, and consequently the sod formed is denser and firmer than that of Red-top. The difference in colour of flowering panicles is not as striking as the names of the plants would suggest, but the general flowering periods are quite separate, Red-top coming into bloom much earlier.

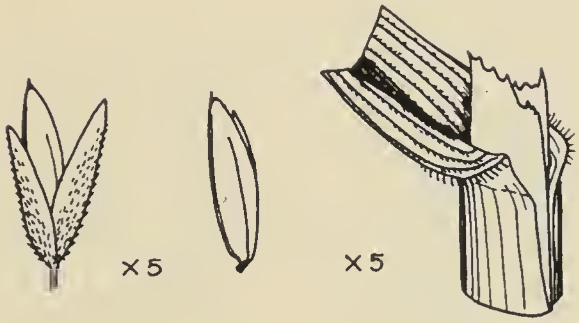
A hybrid between a variety of *A. stolonifera* and *A. tenuis*, testified by Malte, has been collected at St. Paul Island by Perry and Roscoe, 1929.

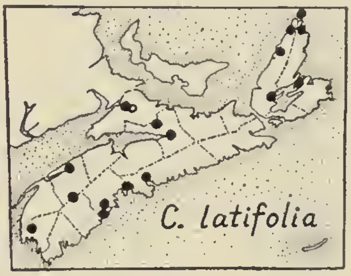
33. CINNA L.

Perennials up to 5 feet high, growing singly or few in a tuft, with wide leaves and large, generally nodding, panicles;

spikelets one-flowered with sharply keeled scabrous glumes; lemma stipitate, with a very short awn from just below the apex; nerves of the palea appearing as one; stamen one.

1. ***Cinna latifolia*** (Trev.) Griseb. DROOPING WOOD-REED





Scattered to common in wet woods, well-drained swamps, and along alluvial ground throughout. Nfld. to Alaska, south to Connecticut.

Cinna arundinacea L. reported from near Bedford, Halifax Co., in Lindsay's Catalogue and repeated by Macoun, is not represented in any of the herbaria visited. A sheet labelled "*Cinna*, Lily Lake, Bedford, June 29, '72" in Lindsay's collection at the Provincial Museum is *Dulichium arundinaceum.*

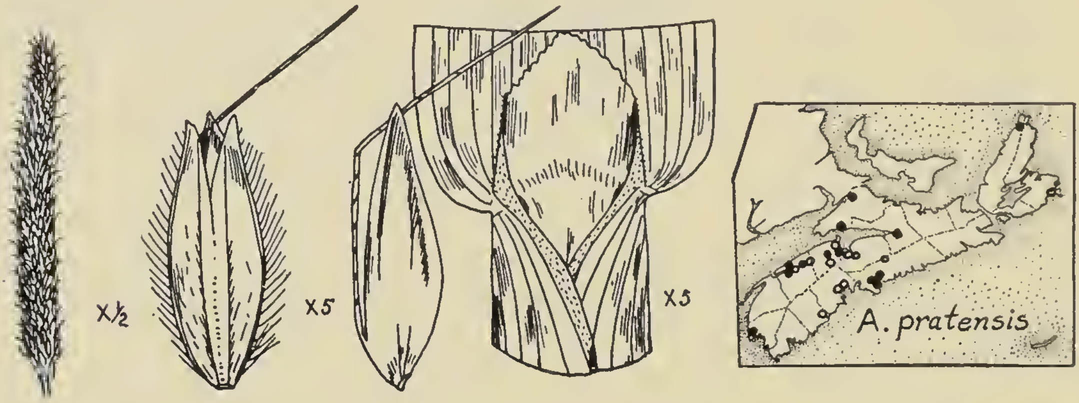
34. ALOPECURUS L.

Perennials with densely-flowered spike-like panicles very similar to *Phleum*, but differing in being softer and by having conspicuous awns. Spikelets broad and flat; glumes long-pubescent, particularly on the keel, and generally joined together towards the base; lemma shorter or about the same length as the glumes and awned on the back; palea wanting; leaves with membranous ligules and inflated upper sheaths.

a. Panicle large, 7 to 10 mm. thick; spikelets about 5 mm. long; awns long and conspicuous
1. *A. pratensis*

a. Panicle smaller, 2 to 6 mm. thick; spikelets 2 to 3.5 mm. long.
  b. Awns arising from near the middle of the lemma, barely extending beyond the glumes.
    2. *A. aequalis*
  b. Awns arising from near the base of the lemmas, extending 2 to 3 mm. beyond the glumes.
    3. *A. geniculatus*

1. ***Alopecurus pratensis*** L. MEADOW FOX-TAIL

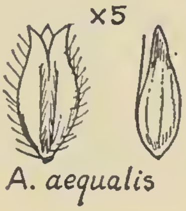


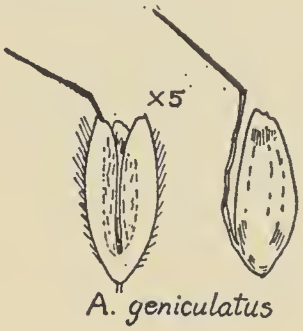
A tall leafy perennial with the inflorescence resembling that of the Timothy, but much softer and flowering earlier in the season. It is a valuable forage grass and has been used in Europe and America when an early growth is desired. However, in some respects, it does not seem as desirable a grass as Timothy and other cultivated grasses since it soon becomes tough and unpalatable. Extensively naturalized and common in rich meadow lands and along roadsides in many parts of the province, often making up a considerable proportion of the grasses in such places. Nfld. to Alaska, south to Delaware; Eurasia; occasionally cultivated.

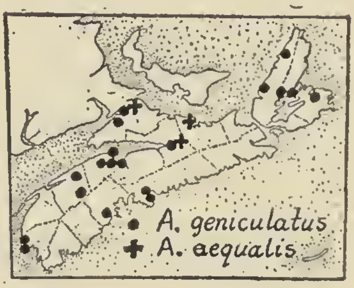
2. ***Alopecurus aequalis*** Sobol. SHORT-AWN FOX-TAIL

An erect or spreading semi-aquatic species usually not rooting at the nodes. Localized in distribution; in water and wet places, Pictou (coll. MacKay, 1880), in shallow pools along the Salmon River above Truro, and common in spring pools and ditches south of Amherst. N. S. to Alaska, south to Pennsylvania; native. (*A. aristulatus* Michx., *A. geniculatus*, var. *aristulatus* Torr).

3. ***Alopecurus geniculatus*** L. WATER FOX-TAIL







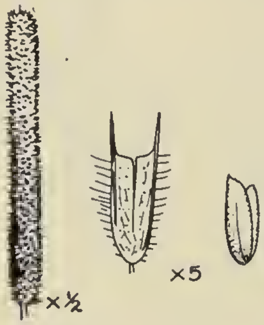
Similar to the above, decumbent at the base and usually rooting at the nodes; inflorescence with the awns conspicuous. Common throughout in wet pastures and fields, in ditches or around the edges of ponds, sometimes growing into shallow water. It is often one of the first grasses to occupy the bare muddy areas along ditches and dyke roads, where the soil is sticky, and drainage and soil aeration poor. Nfld. to Saskatchewan, south to Virginia; introduced.

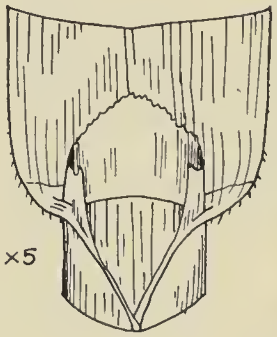
The spikelike panicles of this species mature over a prolonged period during the season, as in some other introduced species (*Poa trivialis, Holcus lanatus*). The great variation also shown in their length and breadth, even on stems originating from the same plant, must be due to seasonal moisture conditions. A variety *microstachyus* Uechtr. with small panicles (mostly 1 to 2 cm. long) is reported as "abundant in some roadside ditches at Yarmouth" (Fernald, 1921, p. 229). Examination of some of the material on which this record is probably based, show it to be merely a depauperate plant collected in mid-summer from "exsiccated roadsides" (Fernald et al., no. 19878) with panicles mainly 2 to 3 cm. long. Plants from Cheticamp with spikelets 1.2 to 3.0 cm. long, and from elsewhere, approach the small extreme in size.

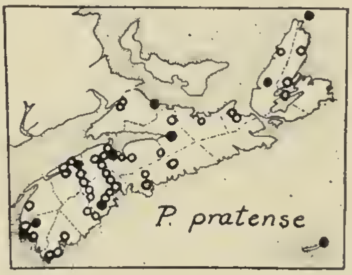
35. PHLEUM L.

Tall perennial grass with culms arising in a tuft, with bulbous basal internodes; terminal panicles dense, cylindrical and spike-like, firmer and rougher than in *Alopecurus* which it resembles; spikelets 1-flowered; glumes equal, compressed, ciliate on the keels, and awn-pointed; lemma much shorter, membranous and falling away with the grain leaving the glumes on the stalk for some time afterwards; ligule white membranous, notched on either side; blades broad, glabrous, except for minute cilia at the very base.

1. ***Phleum pratense*** L. TIMOTHY







The most abundant and most valuable hay grass grown in the province. Grown extensively in meadows, and found equally abundant along roadsides and in waste places. The species appears to be one of the most palatable of forage grasses and is adapted to a wide range of well-drained soils.

36. MUHLENBERGIA Schreb.

Low to tall perennial, tufted grasses; spikelets 1-flowered in open or contracted panicles, with the glumes usually shorter than the lemmas and obtuse to awned; lemma 3-nerved, acute or awned from the tip, sometimes with a few pilose hairs towards the base.

a. Rhizomes lacking; culms slender, often decumbent at the base and rooting at the nodes; panicles loose and open, the spikelets on capillary pedicels; glumes less than half the length of the lemmas.

1. *M. uniflora*

a. Rhizomes short, scaly and knotted; culms erect at the base, and stouter; panicles contracted and densely-flowered, the spikelets on short pedicels; glumes about the length of the lemmas.

  b. Glumes with stiff awn-like tips, much exceeding the awnless lemmas; panicle interrupted towards the base, with the branches short and appressed.

2. *M. racemosa*

  b. Glumes acuminate, about the length of the lemmas or shorter; panicle with the lower branches 1 to 3 cm. long and somewhat spreading.

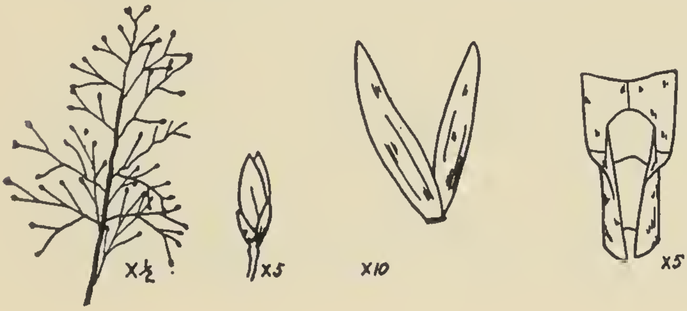
    c. Lemma not long-awned.

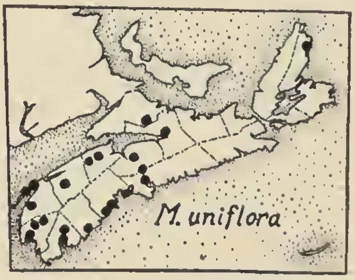
3. *M. foliosa*

    c. Lemma with an awn 4 to 10 mm. long.

3a. *M. foliosa*, var. *setiglumis*

1. *Muhlenbergia uniflora* (Muhl.) Fern.

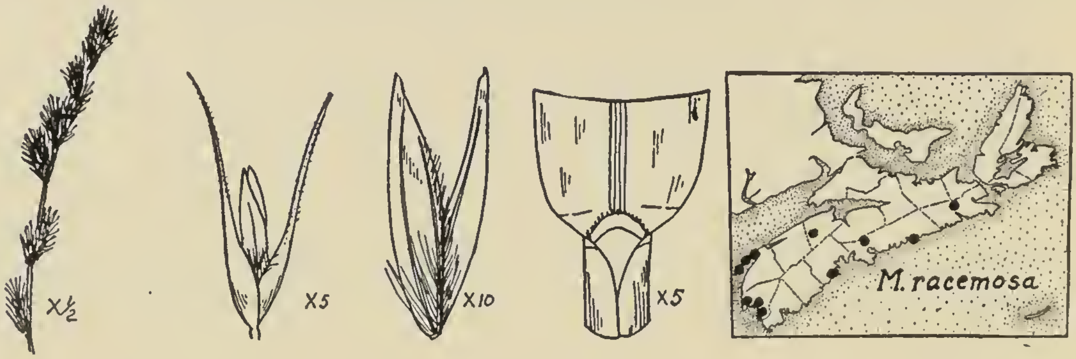




A delicate and neat perennial, 2 to 4 dm. high, with open panicle of small dark-purple spikelets. Common in peat swales, bogs, and sandy sterile soils in the southern and western section of the province, east to Halifax County with isolated stations in Cumberland, Colchester and Victoria Counties. To be expected in any part of the province. (*Sporobolus uniflorus* (Muhl.) Scribn.).

In some plants a few spikelets towards the tips of the branches may be 2-flowered. These show a transition to var. *terrae-novae* Fern. (*Rhodora* 29: 10-14, 1927), the common variety of Newfoundland. This has most of the spikelets 2-flowered, the upper floret staminate and the lower perfect, on shorter pedicels in a somewhat contracted panicle.

2. ***Muhlenbergia racemosa*** (Michx.) B.S.P. MARSH MUHLY



Perennials with culms 5 to 10 dm. high; leaves flat, 2 to 5 mm. wide; panicle narrow and rather bristly, 3 to 10 cm. long, usually purplish. Common in peaty swales, cobbly shores and brook margins throughout the province. Nfld. to British Columbia, south to Maryland.

3. ***Muhlenbergia foliosa*** (Roem. & Schult.) Trin.

Resembling the preceding but with the panicle greener, more branched, the spikelets only 2 to 3 mm. long instead of 4 to 6 mm., and with the base of the lemmas long-pilose. Found, so far, only by the wet rocky shore at the headwaters of the Halfway River, Kings County. Maine to Montana, south to North Carolina.

3a. Var. ***setiglumis*** (S.Wats.)Scribn. is likewise known from only one station; rocky margin of the Ste. Croix River, Hants County.

37. SPOROBOLUS R. Br.

Spikelets one-flowered; lemma with the mid-nerve only, not awned; grain falling away readily and the pericarp slipping off when the grain is mature and moist; ligule a fringe of hairs.

1. ***Sporobolus vaginaeflorus*** (Torr.)Wood

SHEATHED DROP-SEED

A bright-green annual, with the panicle enclosed in the upper sheath until after maturity; lemmas about 4 mm. long, sparsely appressed-pubescent; leaf-blades with a few stiff hairs arising from papillae on the margin at the base.

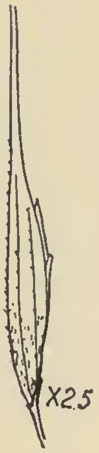
Only one occurrence of the plant is known in the province: in a dry, sandy pasture at Nictaux, Annapolis County. Although identification has been based on immature material, it is probable that the specimen is variety *inaequalis* Fern. (*Rhodora* 35: 108-110, 1933) which has a slightly more northern range than has the typical species. Known from Maine, southward and westward.

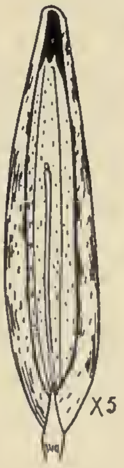
38. BRACHYELYTRUM Beauv.

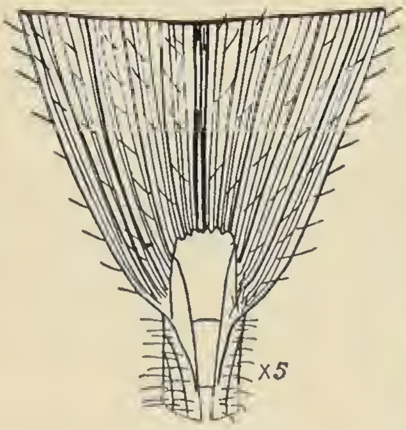
Erect, slender, brittle-culmed perennials 2 to 4 feet high, generally growing in patches from short knotty rhizomes; leaves somewhat pilose, up to 1 cm. wide and 10 cm. long, mostly on the basal half of the culm; panicles contracted with a few spikelets; spikelets one-flowered, very readily breaking away while still green and leaving the two very small, unequal glumes attached to the rachis; rachilla prolonged above the lemma into a long slender bristle. (*Dilepyrum*)

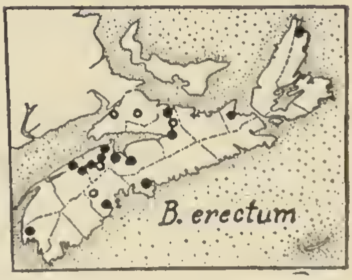
1. **Brachyelytrum erectum** (Schreb.) Beauv.

BEARDED SHORT-HUSK







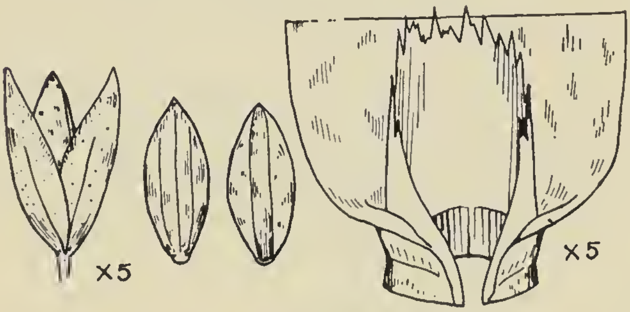


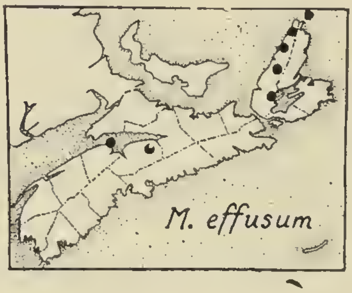
A scattered but never abundant grass, usually growing in wet rocky areas, along shaded streams, in rich moist woods, or occasionally even in open places after the trees or shrubs have been cut off. In all parts of the province. Nfld. to Minnesota, south to Georgia.

39. MILIUM L.

Smooth perennial grass, 3 to 6 feet high, with broad blades; spikelets one-flowered, in an open panicle with branches widely spreading to reflexed; glumes pale green and rounded on the back; lemma smooth and shining, becoming firm and hard, the edges overlapping the palea and grain; ligule long and membranous.

1. *Milium effusum* L. TALL MILLET-GRASS





One of the rarer grasses of the province, confined mainly to rich soils in calcareous regions, either on alluvial soil or on rich hardwood slopes. First collected by Macoun at Whycocomagh in 1883 and at Big Intervale in 1898; reported also from the alluvium of Five-Mile River, Hants County (Fernald, 1921) and from a slope on St. Paul Island (Perry, 1931). It has since been found growing in scattered areas in rich hardwoods on the top of Cape Blomidon (Roland, 1941), in woods north of Cheticamp and at Pleasant Bay. Temperate parts of North America.

40. ORYZOPSIS Michx.

Native perennial grasses, scattered or in small tufts, with the few one-flowered spikelets in narrow or open panicles;

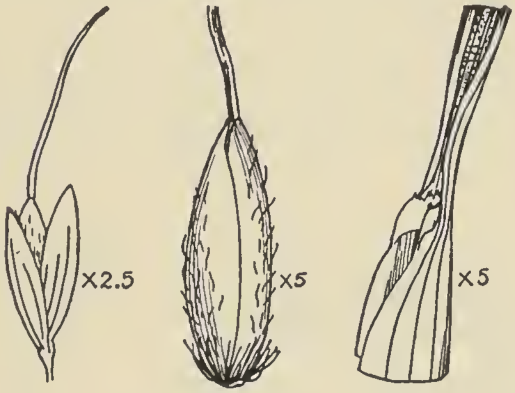
lemma awned from the tip, hard and shiny, appressed-pubescent, closely enveloping the palea and grain.

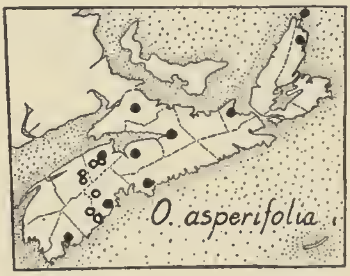
a. Spikelets, excluding awns, 6 to 8 mm. long, in a narrow contracted panicle; blades mostly basal, flat when fresh, 4 to 8 mm. wide.
1. *O. asperifolia*

a. Spikelets, excluding awns, 3 to 5 mm. long, in small diffuse panicles; blades mainly on the stem, mostly involute, less than 3 mm. wide.
  b. Awn less than 3 mm. long, almost straight; panicle smaller, 3 to 6 cm.
  2. *O. pungens*

  b. Awn 8 to 15 mm. long, twisted in two places; panicle larger, 5 to 10.
  3. *O. canadensis*

1. ***Oryzopsis asperifolia*** Michx. RICE-GRASS



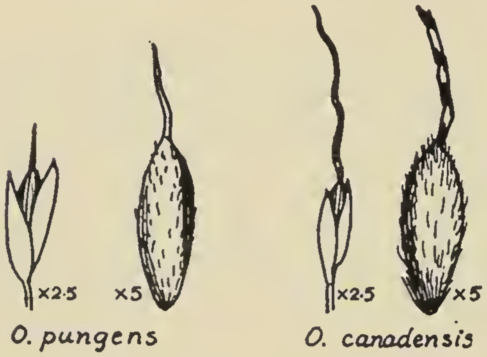


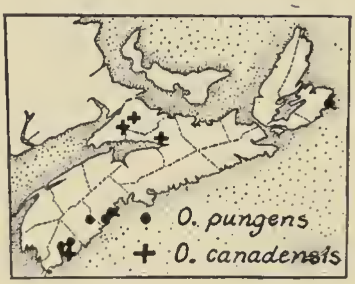
The tufts of rigid long broad leaves, dark-green on the back and pale-green above, are characteristic of the dry woods or sterile bushy barrens throughout the province. Scattered to common, but never abundant; flowering from late May to early June. Nfld. to British Columbia, south to Connecticut.

2. ***Oryzopsis pungens*** (Torr.) Hitchc.

Characteristic of dry barrens of Shelburne and south-western Lunenburg Counties, occasional in Queens County; also at Mira Bay, Cape Breton County. Smaller than, but very similar to the next. Labrador to British Columbia, south to Connecticut.

3. ***Oryzopsis canadensis*** (Poir.) Torr.





A more northern species than the preceding, extending into the province on the dry and barren soils in Cumberland and central Colchester Counties; found also in dry pine woods, near Jordan Falls, Shelburne County. Nfld. to Alberta, south to Nova Scotia, New York, and northern Michigan. (*Stipa canadensis* Poir.)

Tribe V. **CHLORIDEAE**

41. SPARTINA Schreb.

Perennial grasses with extensively creeping, scaly rhizomes; inflorescence of two to many spikes arranged along a central stalk; spikelets one-flowered, much compressed laterally, sessile and closely overlapping along one side of the axis of the spike; glumes of unequal length, the lower shorter, the upper longer than the lemma; lemma with only the midnerve prominent; palea slightly longer than the lemma, two-nerved; ligule a row of short hairs.

a. Blades more than 5 mm. wide, flat towards the base and inrolled towards the tip when fresh; plants with stout upright culms 3 or more mm. in diam., 10 to 20 dm. high.

b. First glume as long as the lemma, very rough-ciliate on the keel; second glume tapering to an awn-like tip as long again as the lemma; inflorescence open, purplish and slender-waving; brackish to fresh water.

1. *S. pectinata*

b. First glume about half as long as the lemma, rarely smooth; second glume without the long awn-like tip, barely exceeding the lemma; inflorescence erect, crowded, yellowish; growing only next to salt water or in very brackish soil.

c. Lemmas glabrous.

2. *S. alterniflora*

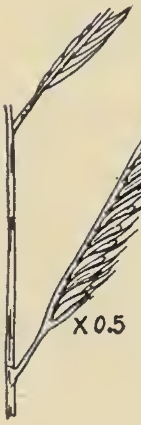
c. Lemmas sparsely pilose.

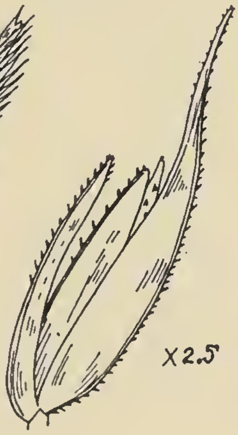
2a. *S. alterniflora*, var. *pilosa*

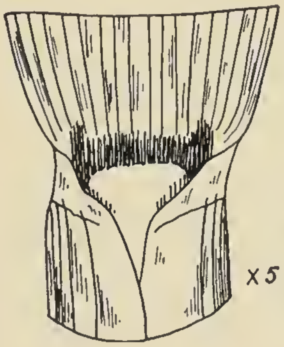
a. Blades less than 3 mm. wide, and involute even when fresh; plants with slender decumbent culms less than 2 mm. in diam., growing in dense leafy mats, mostly 3 to 6 dm. high.

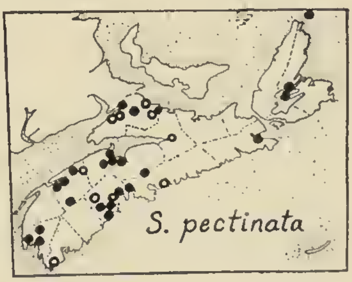
3. *S. patens*

1. *Spartina pectinata* Link TALL CORD-GRASS, BROAD-LEAF









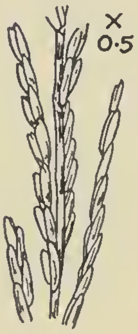
This is the tallest of our cord-grasses and is not restricted to saline soils as are the other two species. It is common bordering salt marshes or along the ditches and drains where free water has carried away most of the salts, and elsewhere in the province wherever open ditches, streams and sloughs occur. Across the continent; along salt marshes from Nfld.

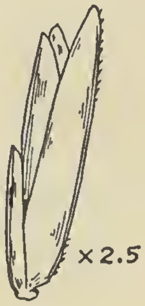
southward. (*S. cynosuroides* of older records, *S. Michauxiana* Hitchc.)

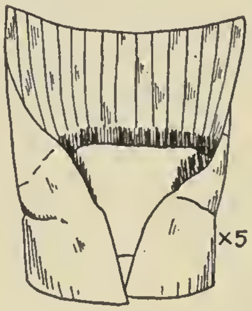
The extreme variation with narrow, slender, spreading spikes and appressed awns, var. *Suttiei* (Farw.) Fern. (*Rhodora* **35**: 258-260, 1933) is reported as ranging from P. E. I. and N. S. southward and westward. Most of the N. S. collections appear intermediate between this variety and the typical species. Cytological evidence, moreover, does not show any difference between the two segregations (Church, G. L., *Amer. Jour. Bot.* **27**: 269, 1940).

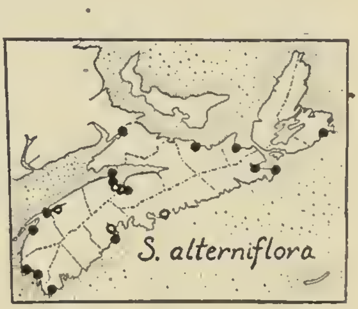
2. *Spartina alterniflora* Lois.

SMOOTH CORD-GRASS, SALT MARSH-GRASS







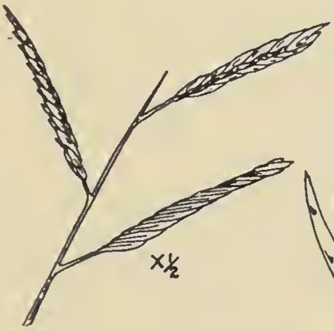


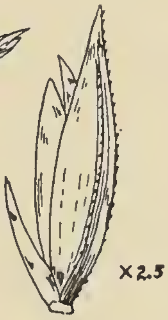
This is the characteristic grass of our salt marshes and is frequently the single seed-plant colonizing the inter-tidal zone. The success of this species in growing under the rigorous conditions of complete or partial submergence with salt water at every tide has been attributed (Church, l c.) to a high degree of polyploidy which allows the throwing off of numerous ecotypes varying in their environmental requirements.

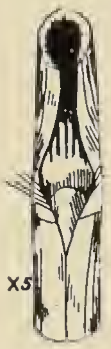
The dense leafy upright growth is important, both in protecting the shores from erosion, and in causing the deposition of fine tidal silts on the extensive marshes particularly in the region surrounding the Bay of Fundy. Quebec to Nfld. along the tidal marshes to Texas; Europe. (*S. stricta*, var. *glabra* of earlier records)

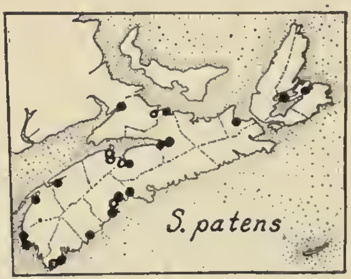
2a. Var. **pilosa** (Merr.) Fern. has been reported (Fernald, 1922) to occur "apparently frequently on salt marshes from Yarmouth County to Annapolis County and presumably beyond." Although this pilose variety is undoubtedlydistinct, since it is different from non-pilose plants also in certain cytological characteristics, the lemmas show all degrees of pubescence from a sparse pilosity to a scabrous or glabrous condition even in the same inflorescence. Var. *pilosa* is a taller, more robust plant with more spikes composing the inflorescence and flowering later than the typical form. It is to be considered an ecotype confined to brackish flats rather than to saline tidal marshes.

3. ***Spartina patens*** (Ait.) Muhl. SALT MEADOW CORD-GRASS









A low grass forming dense matted dark-green patches on parts of the salt marshes above the *S. alterniflora* zone. Found around the coast wherever suitably protected shores are present. If this grass is repeatedly cut for hay, it gradually dies out and is replaced by *Puccinelia* and other salt-marsh plants (Chapman, V. J., *Rhodora* 39: 53-57, 1937). Frequently the only areas on the marsh where this grass persists are around the staddles or corners of the dykes where mowing-machines cannot reach it. Along the coast from Quebec to Texas, and in saline marshes inland. (*S. juncea* of earlier records)

TRIBE VI. PHALARIDEAE

a. Lemmas of the sterile florets larger than the fertile floret; plants bitter-tasting and sweet-scented when dry; inflorescence brownish; flowering early in summer.

  b. Glumes equal in size and shape; lower florets staminate, their lemmas awnless, broad and acute; inflorescence an open panicle; long tough basal leaves appear much after flowering.

42. *Hierochloë*

  b. Glumes very unequal, the second much longer and broader, generally enclosing the floret; lower florets neuter, their lemmas awned, slender and 2-lobed at the apex; inflorescence spike-like, borne on leafy culms.

43. *Anthoxanthum*

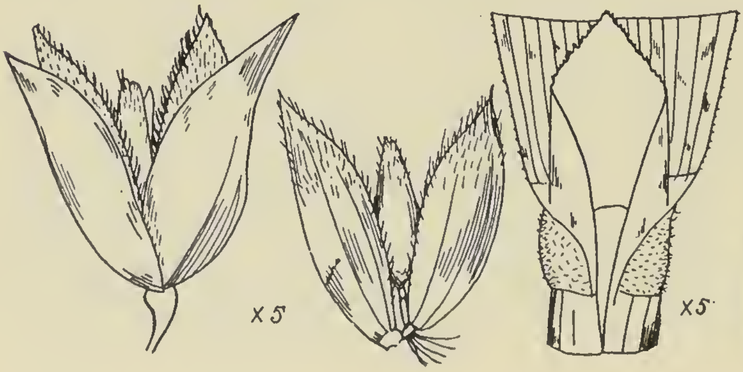
a. Lemmas of the sterile florets much shorter than the fertile floret, or reduced to hairy scales; plants not bitter or scented; inflorescence greenish, appearing in middle or late summer.

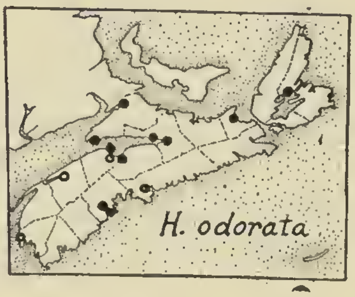
44. *Phalaris*

42. HIEROCHLOË R.Br.

Perennial grass with underground rhizomes and small open panicles with rather few brownish, shining spikelets; spikelets with two broad boat-shaped glabrous glumes, with a single fertile floret between two larger staminate ones; leaves 2 to 5 mm. wide; ligule firm and membranous.

1. ***Hierochloë odorata*** (L.) Wahl. SWEET-GRASS, HOLY-GRASS





This is one of our earliest flowering grasses, with the panicles becoming conspicuous in early May and flowering before June. The long green leaves, which are tough and roll in readily on drying, arise from separate basal offshoots and do not appear until later. They have the bitter taste of coumarin which on drying gives the persistent pleasant fragrance for which the plant is noted; and on this account are often gathered extensively by the Indians and used in making fancy baskets. The leaves of *Anthoxanthum odoratum*, also coumarin-scented, are not suitable for this purpose. The grass is found in many places around the province, growing on low-lying, moist, heavy soil, generally in the proximity of, or on the upper areas of the tidal marshes.

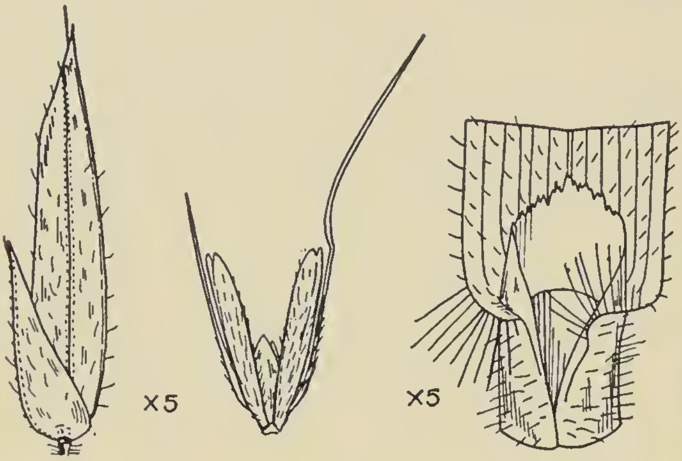
All the plants found in eastern Canada have been put in the variety *fragrans* (Willd.) Richter, which is somewhat different from the typical plant as found in Europe and in the western parts of the continent (*Rhodora* **19**: 152, 1917). It is doubtful, however, whether this distinction should be maintained.

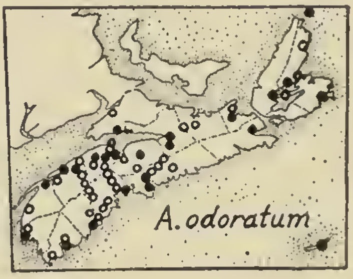
43. ANTHOXANTHUM L.

Low, tufted perennial grasses with dense spike-like brownish-yellow panicles; spikelets with unequal glumes and one fertile floret between two sterile ones; sterile florets each reduced to a hairy long-awned scale-like lemma; blades with conspicuous marginal hairs at the base; ligule membranous.

1. *Anthoxanthum odoratum* L. SWEET VERNAL-GRASS

An early-maturing grass common in old hayfields, roadsides and waste fields throughout the Maritime Provinces. This species used to be seeded in the hay mixture to give a scent to the hay, but now is considered undesirable since cattle do not relish it. It flowers much earlier than the more valuable hay species and by the time the hay is cut, it consists of nothing but slender dry culms inconspicuous in the stand and of no value for forage. Widely introduced from Eurasia.





44. PHALARIS L.

Perennial or annual grasses with upright culms bearing terminal spike-like panicles of flattened spikelets; spikelets with broad equal glumes, and one fertile floret between two greatly-reduced sterile ones; lemma of the fertile floret smooth and readily falling away from the glumes at maturity; ligule long, whitish and membranous; awns absent; plant glabrous.

a. Plants annual; panicle oval, dense and spike-like; lemmas broad-winged, white with green stripes.

1. *P. canariensis*

a. Plants perennial; panicle elongated, branched, contracted after flowering; lemmas pale, not broad-winged.

b. Leaves green.

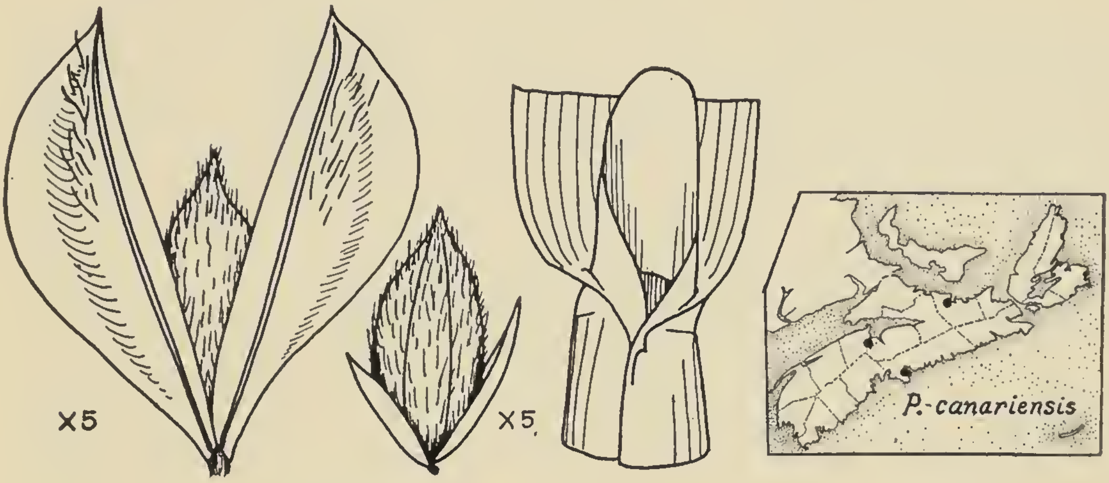
2. *P. arundinacea*

b. Leaves striped with white.

2a. *P. arundinacea*, var. *picta*

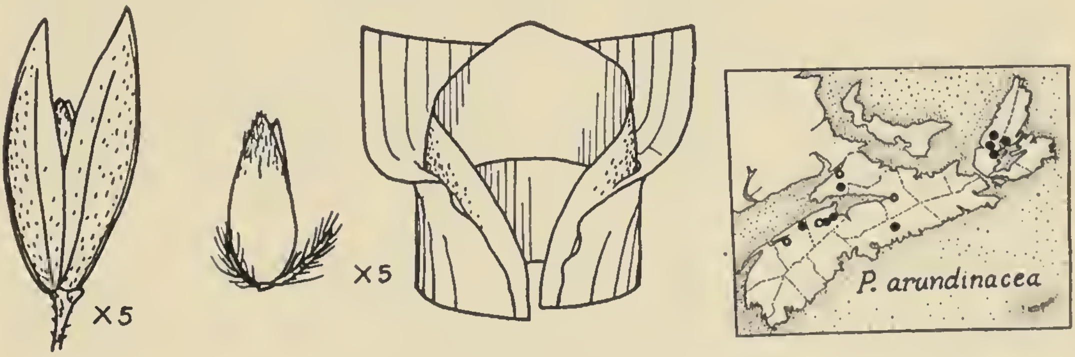
1. *Phalaris canariensis* L. CANARY-GRASS

Introduced in the form of canary and bird seed, this attractive species is sometimes encountered along roadways, on ballast, or in city dumps. Only three specimens have been seen from the province. Pictou (coll. McKay, 1883), Wolfville (coll. Perry, 1912), Halifax (coll. Brown, 1940). Being an annual, it does not persist or become weedy.



2. *Phalaris arundinacea* L. REED CANARY-GRASS

This tall broad-leaved species of mucky soils, wet meadows and along streams, is not of common occurrence, although it has been found at widely-separated points throughout the province; and in the proper habitat, as along the rivers above Kentville or Parrsboro, it may form a considerable part of the grass in the wetter areas. Its leafy nature and vigorous growth makes it an excellent hay grass for wet land. The lemma of the fertile floret is smooth and shiny and slips



out of the heads readily very soon after flowering, thus making the harvesting of seed difficult. N. S. to Alaska, southward.

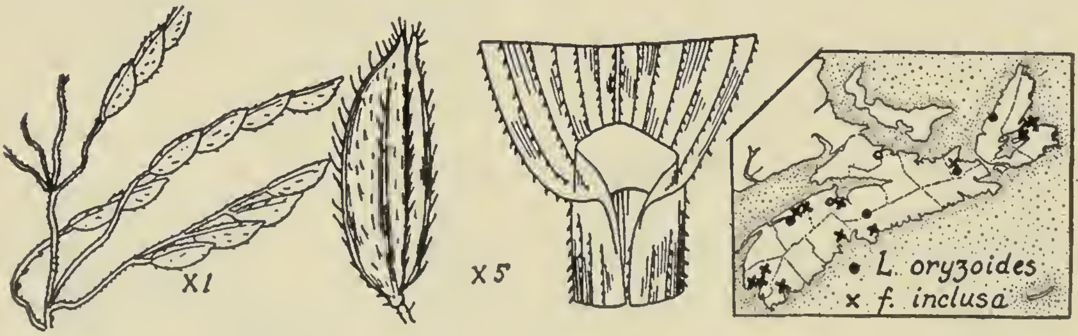
2a. Var. ***picta*** L. is the Ribbon Grass of gardens where it is frequently planted for its ornamental leaves. It is persistent, easy to grow, and spreads by rhizomes as does the typical species. It may be found in any of the towns and cities in the province.

TRIBE VII. **ORYZEAE**

45. LEERSIA Swartz

Bright-green broad-leaved grasses with very rough sheaths and blades, growing in wet soil or in shallow water; panicle with many spikelets on slender branches, emerging in the latter part of the summer or completely enclosed in the sheaths with the flowers remaining cleistogamous; spikelet one-flowered, strongly flattened laterally and without glumes; lemma broad, firm, coarsely hispid, and almost oval in shape, awnless, 4.5 to 6.0 mm. long.

1. ***Leersia oryzoides*** (L.) Swartz RICE CUT-GRASS



Sometimes forming dense, tangled, clinging masses of foliage in ditches, swamps and wet waste lands. The leaves are a bright yellowish-green; culms frequently a meter or more long with the panicle exserted 10 cm. or more from the upper sheath when in flower. Not nearly so common in the province as the following form, being found in Annapolis, Halifax, Antigonish, and Inverness Counties. More abundant eastward and southward across the continent.

Forma ***inclusa*** (Wiesb.)Dörfl. has the inflorescence enclosed in the inflated sheaths or breaking out the sides, never exserted far beyond the top of the sheath. The leaves are darker green and the sheaths often purplish, the whole plant tending to be shorter than the typical species. Found in many parts of the province, frequently in the shallow water or in the wet soil along the margin of lakes. Due to the hidden or late emerging panicles this grass is difficult to recognize by its flowering parts; but it is readily identified by its sharp scabridity and the dense fringe of reflexed white hairs at the culm-nodes. (*f. clandestina* Eames)

Forma ***glabra*** Eaton occurs when the leaves are submerged in the water and become smooth. However, if any of the leaves of a plant happen to be borne permanently above the surface, they have the typical scabridity. Fernald (1921, p. 229) reports this essentially smooth variation completely submerged in Trefry's Lake, Arcadia. Plants from the Roseway River above Shelburne, submerged for the greater part of their length, have the submerged leaves smooth but the leaves above the water-line rough.

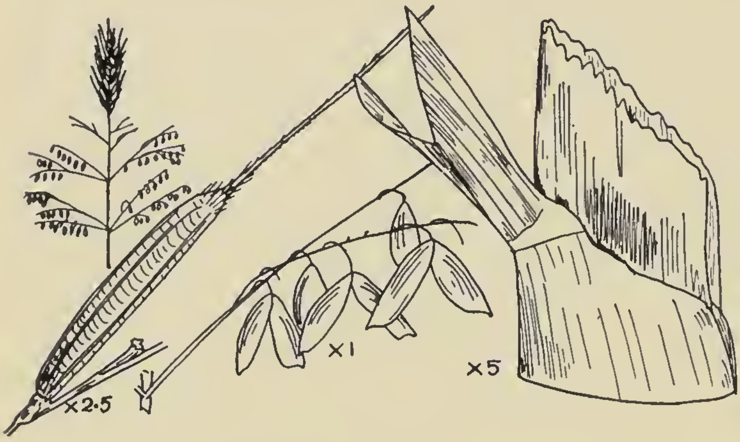
TRIBE VIII. **ZIZANIEAE**

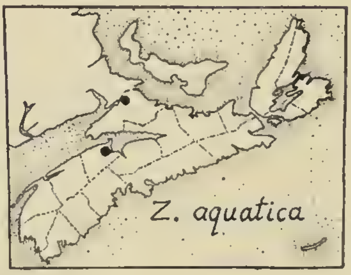
46. ZIZANIA L.

Tall, broad-leaved aquatic grasses with monoecious inflorescences of 1-flowered spikelets; staminate spikelets pendent from the widely-spreading lower branches of the panicle; glumes absent; lemma and palea membranous; stamens six; the whole spikelet falling away soon after anthesis: pistillate spikelets on the erect stiff branches of the upper part of the panicle; glumes obsolete; lemma hard, bristly-scabrous, long awned, enclosing the long, black grain; leaves glabrous:

ligule long and membranous. Fassett, N. C., A study of the genius *Zizania*. *Rhodora* 26: 153-160, 1924.

1. ***Zizania aquatica*** L. NORTHERN WILD RICE





A grass native to North America and growing abundantly in the shallow water of lakes, streams and sloughs in the interior of the continent and providing food and shelter for wild water fowl. Also harvested by certain tribes of Indians for food. Now sown to some extent in bird sanctuaries to attract wild ducks and geese. The viability of the seed is rapidly lost on drying. The only records of the plant from Nova Scotia are from Long Lake, near Amherst (coll. Groh, 1935), and Canard River, Upper Canard (coll. Roland, 1939). All of our plants are var. ***angustifolia*** Hitchc.

TRIBE IX. **PANICEAE**

a. Spikelets not surrounded by bristles from below the base; inflorescence a diffuse panicle, or of several racemes.
  b. Spikelets not crowded, longer pedicelled; glumes and sterile lemma not awned, often pubescent but never stiffly hispid.
    c. Spikelets in pairs in two rows along one side of an axis; inflorescence of several racemes, digitate at the top of the culm.
      47. *Digitaria* (p. 271)
    c. Spikelets in diffuse panicles.
      48. *Panicum* (p. 272)

b. Spikelets crowded along one side of the panicle branches, almost sessile, with the glumes or sterile lemma awned and stiffly hispid.

49. *Echinochloa* (p. 282)

a. Spikelets with 1 to many long bristles from below the base; inflorescence a dense spike-like panicle.

50. *Setaria* (p. 283)

47. DIGITARIA Heister

Low, introduced, weedy grasses with the panicle consisting of a number of radiating branches bearing spikelets in pairs closely appressed along them in a zig-zag double line. Spikelets with a minute first glume, a second glume as long as the spikelet or half as long, one sterile lemma, and a fertile floret in the center.

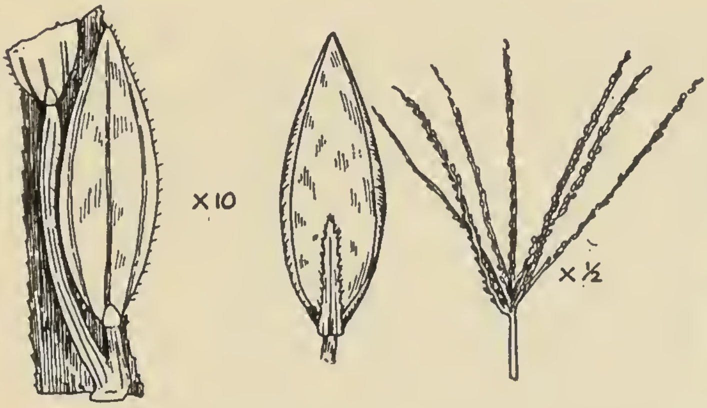
a. Lower blades and sheaths pilose; plants erect; panicle-branches 4 to 6, joined at nearly the same point to the main axis; second glume only half the length of the spikelet

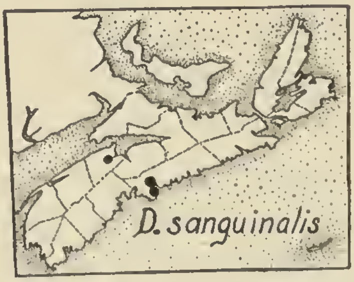
1. *D. sanguinalis*

a. Lower blades and sheaths glabrous; plants usually widely spreading; panicle-branches 2 to 4, more or less separated; second glume nearly as long as the spikelet.

2. *D. Ischaemum*

1. ***Digitaria sanguinalis*** (L.) Scop. CRAB-GRASS

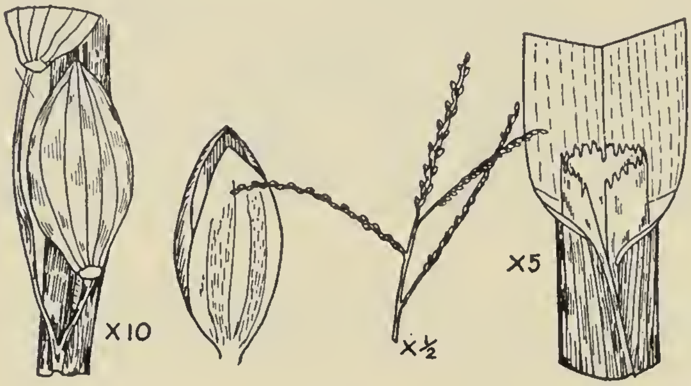


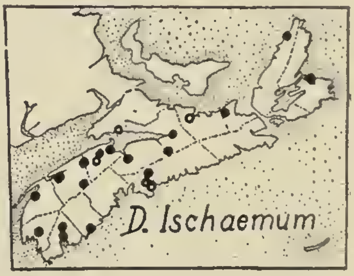


A branching, generally purplish plant, spreading from the decumbent base. Both this and the following species are best recognized by the digitate-branching type of inflorescence. But recently introduced into the province; common in gardens and waste places around Halifax, Bedford, Kentville, and probably elsewhere. Native of Europe; throughout the U. S. and southern Canada.

2. ***Digitaria Ischaemum*** (Schreb.) Muhl.

SMOOTH CRAB-GRASS





Smaller and smoother than the preceding, at first erect, but soon decumbent and widely spreading, purplish. Much commoner, and becoming a weed around towns, in waste places, and especially on the sandy soil of the Annapolis Valley. Introduced from Eurasia, and widely spread. (*D. humifusa* Pers.)

48. PANICUM L.

Annual or perennial grasses of diverse appearance, with rather characteristic oval, plump spikelets in open or compact panicles; ligule a fringe of hairs; glumes 2, very unequal, the first often minute, the second large and similar to the sterile lemma; sterile lemma bearing a minute palea; the fertile lemma slightly smaller, blunt and hardened, the margins enclosed around a palea of the same texture. The cultivated millet is the type species. *Panicum* species are common in the southern part of the province and in light sandy soils, becoming progressively rarer northeastward.

a. Basal leaves different from those of the stem, shorter and stouter, forming a winter rosette.

  b. Leaves narrow, often 20 times as long as wide, exceeding the panicles; nodes bearded; ligule less than 1 mm. long.

    c. Spikelet about 3.5 mm. long, sharp-pointed or beaked.

      1. *P. depauperatum*

    c. Spikelet 2.2 to 2.4 mm. long, blunt and not beaked.

      2. *P. linearifolium*

  b. Leaves not nearly so elongate.

    d. Leaf-blades not heart-shaped at the base, less than 1 cm. wide.

      e. Ligule less than 1 mm. long; spikelets 2.2 to 2.4 mm. long; sheath glabrous.

        3. *P. boreale*

      e. Ligule of conspicuous hairs 3 to 5 mm. long; spikelets less than 2.1 mm. long.

        f. Sheaths glabrous; plants 3 to 9 dm. high; spikelets about 1.5 mm. long.

          4. *P. spretum*

        f. Sheaths more or less pubescent; small plants, rarely over 4 dm. high.

          g. Spikelets 1.3 to 1.5 mm. long.

            h. Sheaths and lower surface of the leaves with shorter appressed pubescence between the longer hairs; axis of panicle finely pubescent; lower panicle branches ascending and not tangled.

              5. *P. meridionale*

            h. Sheaths and both surfaces of the leaf-blades without any pubescence between the long hairs; axis of the panicle usually pilose; lower branches of the panicle spreading and tangled.

              6. *P. lanuginosum*, var. *implicatum*

          g. Spikelets 1.6 to 2.1 mm. long.

            i. First glume less than one-third the length of the spikelet, acute or obtuse; panicle-branches slender, spreading, the lower often reflexed; sheaths glabrous or with spreading hairs.

              j. Axis of panicle spreading-pilose, at least on the lower internodes;. blades mostly pilose above and pubescent below.

                6a. *P. lanuginosum*, var. *fasciculatum*

j. Axis of panicle smooth or with at most a few appressed hairs; blades glabrous to sparsely pilose above and minutely pubescent below.

6b. *P. lanuginosum*, var. *septentrionale*

i. First glume nearly one-half the length of the spikelet, acute; panicle-branches stout, ascending; sheaths with appressed or ascending hairs; blades long-pilose on both sides.

7. *P. subvillosum*

d. Leaf-blades heart-shaped at the base, 1 to 3 cm. wide.

8. *P. clandestinum*

a. Basal leaves similar to the stem leaves, not forming a winter rosette; spikelets mostly longer than 2.0 mm.; plants large, 2 to 20 dm. high.

k. Plants annual, without rootstocks; sheaths pilose or glabrous.

l. Sheaths glabrous; panicle diffusely branched; spikelets 2.5 mm. long; first glume blunt, one-quarter the length of the spikelet.

9. *P. dichotomiflorum*

l. Sheaths densely pilose.

m. Spikelets 3 mm. or less in length, not smooth and shining.

n. Panicle generally less than one-third the length of the plant; spikelets 1.8 to 2.0 mm. long.

10. *P. philadelphicum*

n. Panicle about half the length of the plant; spikelets 2.3 to 3.0 mm. long.

o. Panicle-branches erect and crowded, only at length spreading; leaves scattered on the stem; spikelets up to 2.5 mm. long.

11. *P. capillare*

o. Panicle branches more exserted, the lower reflexed; leaves mostly near the base of the plant; spikelets pointed, about 3 mm. long.

11a. *P. capillare*, var. *occidentale*

m. Spikelets 4 to 5 mm. long, smooth and shining; panicle drooping, one-third or less the length of the plant.

12. *P. miliaceum*

k. Plants perennial, growing in tufts from short rootstocks; sheaths glabrous. Southwestern Nova Scotia only.

p. Plant stout, 10 to 20 dm. high; spikelets 3.2 to 4.0 mm. long, long-pedicelled in diffuse panicles.

13. *P. virgatum*

p. Plant more slender, 2 to 8 dm. high; spikelets short-pedicelled along one side of the nearly unbranched panicle-branches.

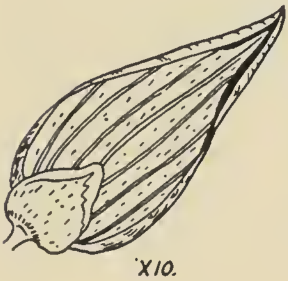
q. Panicle 1.0 to 2.5 dm. long; spikelets 2.4 to 2.7 mm. long, with the upper glume equalling or longer than the sterile lemma.

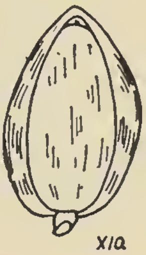
14. *P. longifolium*

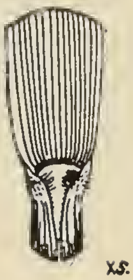
q. Panicle 0.3 to 1.5 dm. long; spikelets 2.7 to 3.4 mm. long, with the upper glume shorter than the sterile lemma.

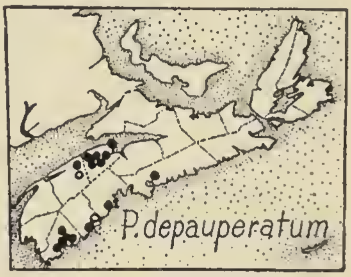
14a. *P. longifolium*, var. *tusketense*

1. ***Panicum depauperatum*** Muhl. STARVED PANIC-GRASS









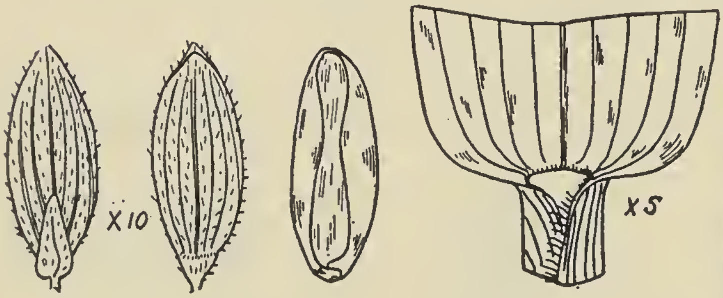
Plants densely tufted, rather low, with slender erect culms. It is readily distinguished by the narrow, very long leaves which reach to the middle of the panicle or above, and by the large spikelets, slightly beaked at the end and very minutely pubescent. The autumnal phase is similar with the basal leaves over-topping the panicles. Very common on the sandy soils of the Annapolis Valley, and scattered on sandy, gravelly or sterile soils elsewhere, from Shelburne to Halifax County. N. S. to Minnesota, southward.

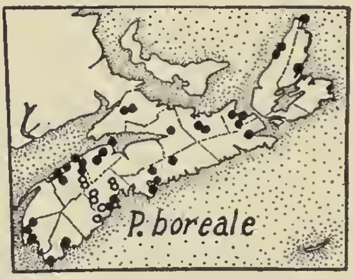
All of our plants belong to the northern extreme, var. ***psilophyllum*** Fern. (*Rhodora* 23: 193, 1921), characterized by glabrous sheaths. Its form ***cryptostachys*** Fern. is a dwarfed form growing in very sterile soil, and bearing only reduced basal panicles of 1 to 4 spikelets. Scattered in the province throughout the range of the variety (*Rhodora* 23: 194, 1921).

2. *Panicum linearifolium* Scribn.

The northern extreme of this species with glabrous sheaths, var. ***Werneri*** (Scribn.) Fern. (*Rhodora* **23**: 194, 1921), is represented by collections from Kings County, from sandy soils in the vicinity of Coldbrook by Roland. Formerly known from Maine, westward and southward.

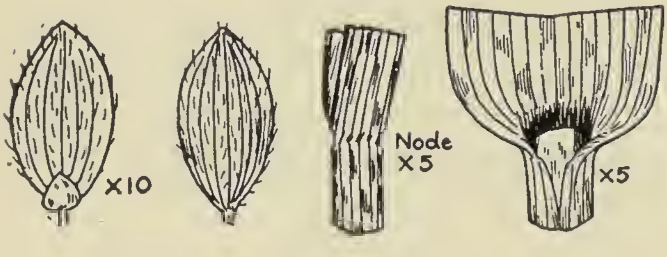
3. *Panicum boreale* Nash NORTHERN PANIC-GRASS

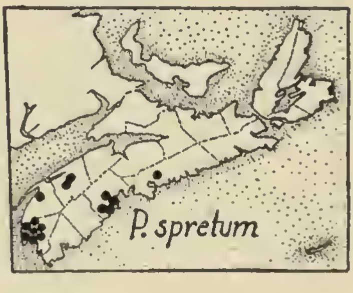




Plants usually erect and glabrous, 3 to 5 dm. high, with leaves 8 to 12 mm. wide. Common in damp or moist situations throughout the province. Nfld. to Minnesota, south to New Jersey and Indiana.

4. *Panicum spretum* Schult.





Vernal phase tall and erect, 3 to 9 dm. high; autumnal phase usually reclining, much branched, often with many short branches at the nodes; nodes and upper sheaths glabrous. Wet or peaty swales, gravelly or sandy upper borders of lake beaches, or wet margins of pools and ditches; scattered from

Yarmouth County, eastward to Halifax County. A coastal-plain plant; from N. S. to Texas; also found in Indiana.

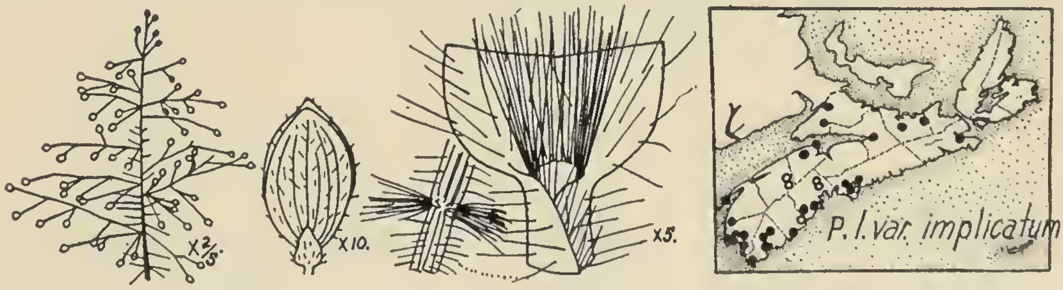
5. *Panicum meridionale* Ashe

Known at but one station east of Massachusetts. Collected by the Gray Herbarium Expedition on the cobbly beach of Gavelton (Butler's) Lake, Gavelton, Yarmouth County (*Rhodora* **24**: 161, 1922).

6. *Panicum lanuginosum* Ell.

This is an extremely variable and difficult species in a section of the genus where specific lines are very indistinct. Numerous species have been proposed that appear to be but ecological forms or minor variations. Recently a number of these have been combined under a single species, of which three better-marked varieties are found in the province. Fernald, M. L., *Panicum Lindheimeri*. *Rhodora* **23**: 223-228, 1921. Fernald, M. L., Realignments in the genus *Panicum*. *Rhodora* **36**: 77-78, 1934.

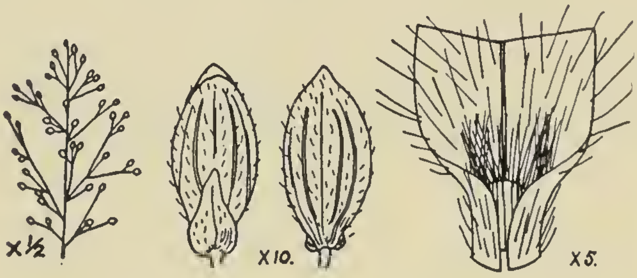
6a. Var. ***implicatum*** (Scribn.) Fern. A small plant 2 to 5 dm. high, generally erect, but with a spreading or reclining autumnal form; loosely branched from the middle or lower nodes. This is one of the commoner forms of the province; abundant in the southwestern counties and becoming rarer eastward to Cape Breton. Meadows, bogs, heavy soils but occasionally even in sandy places. (*P. implicatum* Scribn.).

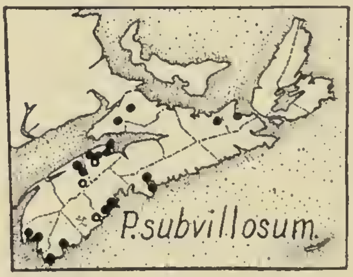


6b. Var. **fasciculatum** (Torr.) Fern. Taller than the preceding, with larger spikelets, and often grading into it. Growing in similar situations from Yarmouth County to Cape Breton, but not nearly so abundant (*P. huachucae* Ashe, var. *fasciculatum* (Torr.) F. T. Hubb.). *P. huachucae* is a trivial form of more open habitats, with stiffer, more ascending leaves. *P. tennesseense* Ashe is likewise considered to be merely a variation. Across the continent.

6c. Var. **septentrionale** (Fern.) Fern. (*Rhodora* 23: 227, 1921). Rare in Nova Scotia. Known only from a wet sphagnous swale at border of Beaver Lake, Yarmouth County (Fernald, 1921); and dry pine and oak woods on steep slopes along the Lahave River, Bridgewater (Fernald, 1922, p. 161).

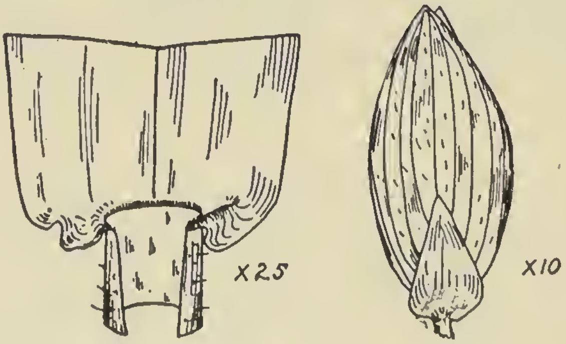
7. ***Panicum subvillosum*** Ashe PANIC-GRASS

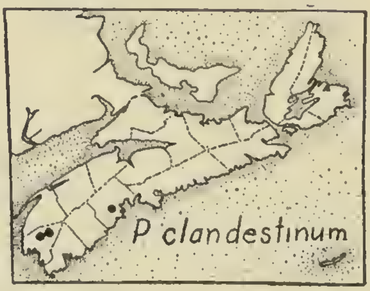




Probably the commonest species of *Panicum* in the province. Common throughout in dry sandy or rocky open soil, fields, pastures, roadsides and barrens.

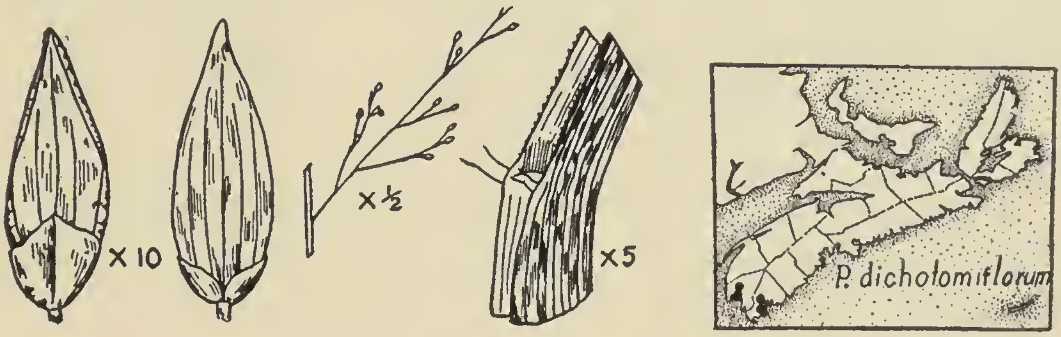
8. ***Panicum clandestinum*** L.





Plants coarse, often in large clumps, 7 to 12 dm. high, with broad leaves up to 3 cm. wide. Occasional in the Tusket Valley, Yarmouth County, in damp, rocky or gravelly thickets (Fernald, 1921); found on the upper border of cobble beach, Wentzell Lake, Lunenburg County (Fernald, 1922). Widely distributed westward and southward.

9. ***Panicum dichotomiflorum*** Michx.



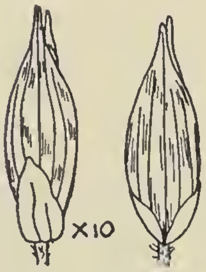
Scattered and rather rare, in the Tusket Valley, Yarmouth County, on sandy and gravelly shores of lakes, and borders of savannahs (Fernald, 1921); found in similar places beside Harper and Welshtown Lakes, Shelburne County (Fernald, 1922). All of our specimens apparently belong to var. ***geniculatum*** (Wood) Fern. (*Rhodora* 38: 387-390, 1936), the coastwise extreme with coarse geniculate stems, enlarged lower nodes, and inflated sheaths. N. S., southward to the Gulf of Mexico.

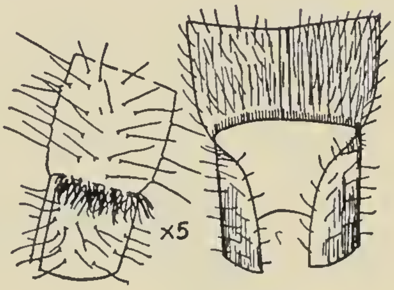
10. ***Panicum philadelphicum*** Bernh.

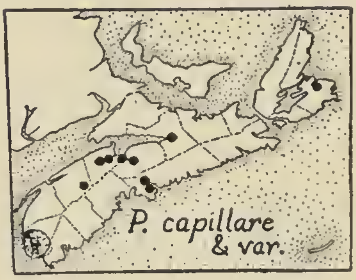
A pilose annual grass with blades 3 to 8 mm. wide; panicle large, very diffuse, nearly as wide as long, with few spikelets on capillary branchlets and pedicels. Plants often prostrate and much branched at the base. Our plants belong to var. ***Tuckermani*** (Fern.) Steyermark & Schmoll, a more northern variation with the swollen bases, pulvini, of the panicle-branches nearly glabrous (*Rhodora* 41: 86-90, 1939). Known by only one collection from the province; cranberry bog, Bridgewater

(McLellan, Sept. 11, 1939). Maine to New York, and scattered westward.

11. ***Panicum capillare*** L. WITCH-GRASS







Large coarse annual plant, with a very large diffuse panicle. Scattered in sandy fields, roadsides, and waste places, sometimes becoming a weed in gardens. Maine, southward and westward, probably introduced into Nova Scotia.

11a. Var. ***occidentale*** Rydb. is a smaller plant with more exserted panicles and larger spikelets. Occasionally seen about railroad yards, as at Windsor Junction, Halifax, and Sydney; obviously introduced. Widely distributed, and commoner westward. (*P. barbipulvinatum* Nash)

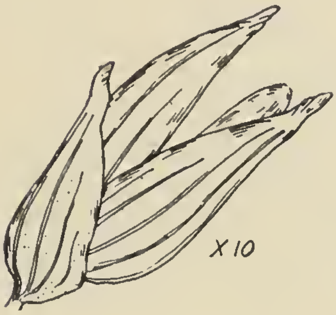
12. ***Panicum miliaceum*** L. BROOM-CORN MILLET

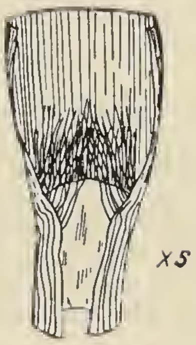
Plants large, 2 to 10 dm. high, with large, usually drooping panicles. Occasionally planted in the province, and sometimes found along roadsides and waste places; not persisting. Cultivated strains and varieties of diverse appearance may be found. Eurasia.

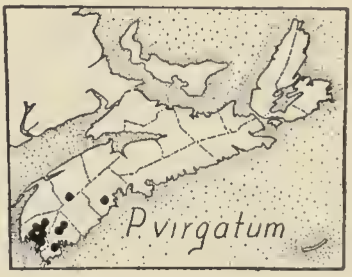
13. ***Panicum virgatum*** L. SWITCH-GRASS

A large coarse species found on sandy, gravelly or cobbly beaches, in thickets, bogs and on peaty borders of lakes; scattered throughout the southwestern part of Nova Scotia. Widely distributed in North America.

Our plants all belong to var. ***spissum*** Linder, a variety with short, ascending, rather than long, creeping rootstocks. This variety reaches its best development in Nova Scotia and eastern Massachusetts (*Rhodora* 24: 11-16, 1922). First reported from the province as var. *cubense* (Fernald, 1921, p. 192).



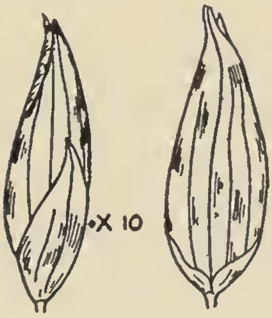


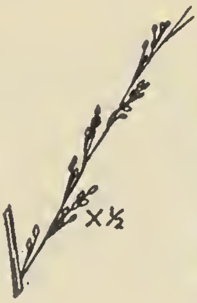


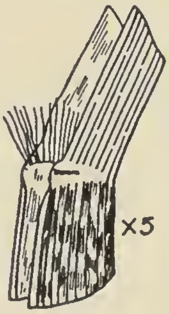
14. ***Panicum longifolium*** Torr.

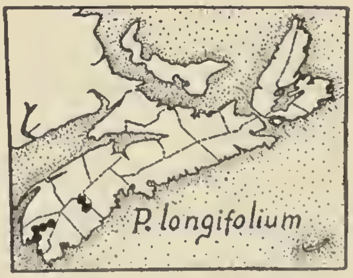
Rather similar to *P. dichotomiflorum* in the appearance of the plant, and shape and size of the spikelets; distinguished by its longer first glume and more compact panicle. Found in two places in the interior of Queens County by Weatherby, and along the Tusket River in Yarmouth County.

The plants occurring on the sandy or gravelly beaches, and peaty margins of lakes in the Tusket River valley have been referred to a separate indigenous variety, var. ***tusketense*** Fern. The distinctions given between the typical species and this variety (*Rhodora* 23: 192-193, 1921) are included in the







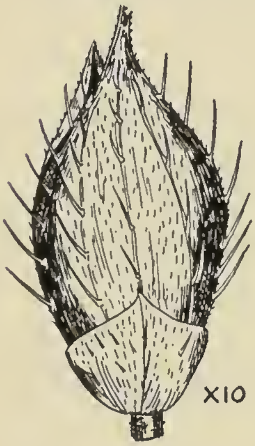


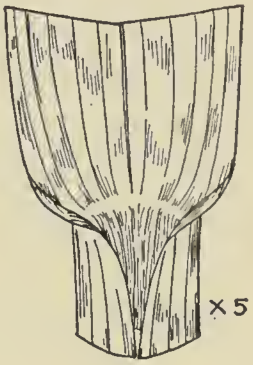
key. However, later collections from Queens County, and even from the Tusket valley seem to be more typical of the species than of the variety. The species is a coastal-plain plant ranging from N. S. to Florida and Texas.

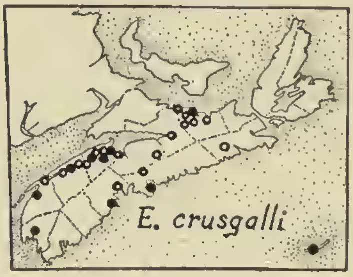
49. ECHINOCHLOA Beauv.

Coarse succulent annual grasses with flattened sheaths, flat blades, and hairy spikelets crowded along the branches of the branched panicle; ligule absent. Spikelets flattened on one side, pubescent, with hispid hairs along the nerves; first glume short; second glume and sterile lemma equal, both very variable as to the length of the awned tips.

1. *Echinochloa crusgalli* (L.) Beauv. BARNYARD-GRASS







Culms erect, up to 3 feet high, often branching at the base; panicle purplish tinged, large, with numerous spreading branches. A common weed in waste ground, along ditches, in gardens and around dwellings, generally growing in rich or moist soil; not becoming a bad weed in field or hay crops. Introduced from the old world, and common throughout.

This grass is very variable in all its characters. The plants may be large or small, the panicle greenish to purplish, the spikelets very hispid, or almost smooth, and the awns very long or nearly absent.

The **typical** plant has most of the spikelets with awns between 3 and 10 mm. long, with some of the spikelets awnless. Besides this form, the following two extremes may be expected to occur throughout.

Var. **mitis** (Pursh) Peterm. has the spikelets awnless or nearly so, any awns being less than 3 mm. long. Found at Grand Pré, and Halifax by M. S. Brown.

Var. **longiseta** (Trin.) Farwell is not so well marked, but has many of the spikelets with awns 2 to 3 cm. long. Grand Pré (coll. Brown).

Var. **frumentacea** (Roxb.) Wight has been occasionally cultivated in the province under the name Japanese Millet, but has not been observed as an escape. The racemes are thick with incurved, appressed branches; the spikelets are awnless and purplish.

50. SETARIA Beauv.

Introduced annual plants, with the inflorescence a terminal bristly spike-like panicle; spikelets awnless, but surrounded by one to many long bristles which arise below the spikelet and represent sterile branchlets; first glume about half the length of the spikelet, the second equalling the sterile lemma; ligule a row of hairs.

a. Bristles below each spikelet numerous; spikelets 3 mm. long, the sterile lemma transversely rugose; base of blade with a few flexuous hairs; margin of sheath glabrous

1. *S. lutescens*

a. Bristles below each spikelet 1 to 3; spikelets 2.0 to 2.5 mm. long, the sterile lemma smooth, or nearly so; blade glabrous; margin of sheath ciliate.

  b. Spikelets articulated below the glumes, falling away entire; panicle cylindrical, not interrupted.

    c. Panicle green, densely-flowered, about 6 mm. long; bristles 1.0 to 1.5 mm. long.

2. *S. viridis*

c. Panicle purplish, irregularly-flowered, generally 2 to 3 cm. long; bristles shorter, less than 1 cm. long.

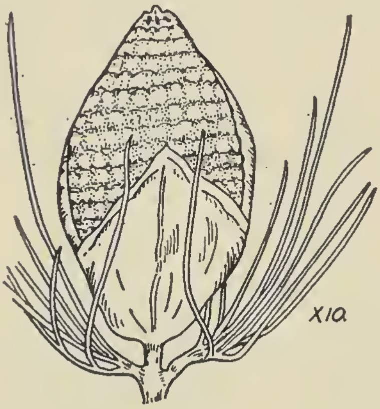
2a. *S. viridis*, var. *Weinmanni*

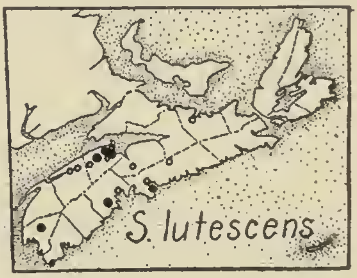
b. Spikelets articulated above the glumes, the fruit shelling out and leaving the glumes and sterile lemma behind; panicle large, usually much interrupted, green, yellow, or purplish.

3. *S. italica*

1. ***Setaria lutescens*** (Weigel) F. T. Hubb.

YELLOW BRISTLE-GRASS, YELLOW FOX-TAIL





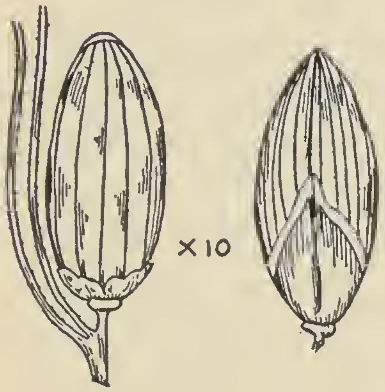
A weedy annual, distinguished by its rather narrow yellow panicles with relatively few large spikelets. Common in the Annapolis Valley on the light or sandy soils, in gardens, orchards and along roadsides; rarer throughout the rest of the province. Introduced from Europe, and widely distributed. (Formerly referred to *S. glauca* (L.) Beauv. *Rhodora* **18**: 232, 1916).

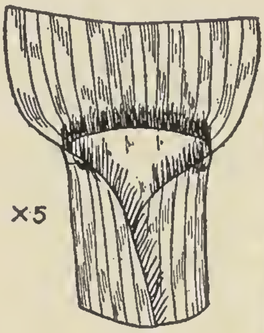
2. ***Setaria viridis*** (L.) Beauv.

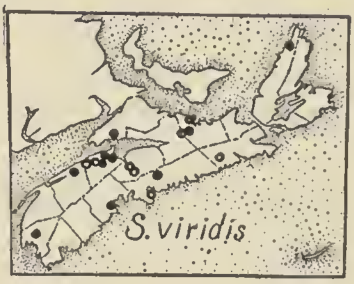
GREEN BRISTLE-GRASS, YELLOW FOX-TAIL

A weed with the numerous small spikelets forming a dense green panicle, growing in light to heavy soils, in gardens, waste places, orchards and roadsides. Common throughout the Annapolis Valley, and scattered in the rest of the province. Introduced from Europe, throughout North America.

2a. Var. **Weinmanni** (R. & S.) Brand is a smaller plant with a purplish color, and culms more or less geniculate at the base. Scattered on light soils in the Annapolis Valley, and occasionally around railroad yards elsewhere. Introduced.







3. **Setaria italica** (L.) Beauv. FOX-TAIL MILLET

A cultivated form of *S. viridis* with more robust culms, broader blades and larger, often lobed panicles. Many different varieties and strains have been used or developed, so that plants of very diverse appearance may be found. Frequently cultivated for summer forage; occasionally found as an escape in waste places. Eurasia; widely introduced.

Setaria verticillata (L.)Beauv.

Recorded, from "Pictou County, N. S. (Sommer's Catalogue)" in Macoun's Catalogue; and in Sommer's Catalogue listed as "*Setaria verticillata.* W. River (Pictou County) Ly." The specimen in Lindsay's collection in the Provincial Museum, on which this record is presumably based, is a plant with large inflorescence which should probably be placed in *S. italica.*

TRIBE X. TRIPSACEAE

51. ZEA L.

Tall, stout, cultivated annual grass with pith-filled culms and broad coarse blades; spikelets unisexual; staminate spikelets 2-flowered and borne in racemes in a large terminal panicle, the tassel; pistillate spikelets with generally one fertile flower, borne in a dense and thickened spike, the ear, surrounded by numerous leaves, the husk, on short lateral branches. This tribe is so distinct and so readily recognised from all our other grasses that it has not been included in the keys. On account of the great modification of the flowering parts, it is believed to be among the most highly evolved of the grasses.

1. ***Zea Mays*** L. INDIAN CORN, MAIZE

Frequently cultivated in well-drained soils and in the warmer sections of the province. Grown for table use (Sweet Corn), or for ensilage, the whole plant being cut up while green. The crop is not grown profitably for feed grain in this region.

REFERENCES

Britton, N. L. and A. Brown. Illustrated Flora of the Northern United States and Canada. 2nd. edition, 1913.

Fernald, M. L. The Gray Herbarium Expedition to Nova Scotia, 1920. *Rhodora* **23**: 89-111; 130-171; 184-195; 223-245; 257-278; 284-301, 1921.

Fernald, M. L. Notes on the flora of western Nova Scotia. *Rhodora* **24**: 157-180; 201-208, 1922.

Ganong, W. F. The vegetation of the Bay of Fundy salt and dyked marshes. *Bot. Gaz.* **36**: 161-186; 280-302; 349-367; 429-455, 1903.

Hitchcock, A. S. Manual of the Grasses of the United States. *U. S. Dept. Agric. Misc. Publ.* 200, 1935.

Lindsay, A. W. H. A catalogue of the flora of Nova Scotia. *Proc. N. S. Inst. Nat. Sci.* **4**: 184-222, 1876.

Macoun, John. Catalogue of Canadian Plants. Part IV, 1888.

Nichols, G. E. The vegetation of northern Cape Breton Island, Nova Scotia. *Trans. Conn. Acad. Arts and Sci.* **22**: 249-467, 1918.

Perry, L. M. Vascular flora of St. Paul Island, Nova Scotia. *Rhodora* **33**: 105-126, 1931.

Robinson, B. L. and M. L. Fernald. Gray's New Manual of Botany. 7th edition, 1908.

Roland, A. E. Notes on the flora of Nova Scotia-II. *Rhodora* **43**: 337-343, 1941.

Roland, A. E. and W. G. Dore. Notes on the flora of Nova Scotia-III. *Rhodora* **44**: 334-338, 1942.

St. John, H. Sable Island, with a catalogue of its vascular plants. *Contr. Gray Herb. Harv. Univ.* **LXII**. 1921.

INDEX TO SPECIES

Page
Agropyron pungens 220
Agropyron repens 220
Agropyron trachycaulum . . . 218
Agrostis canina 246
Agrostis perennans 246
Agrostis scabra 244
Agrostis stolonifera 247
Agrostis tenuis 249
Alopecurus aequalis 252
Alopecurus geniculatus 253
Alopecurus pratensis 252
Ammophila breviligulata 242
Anthoxanthum odoratum . . . 265
Arrhenatherum elatius 234
Avena fatua 233
Avena sativa 233

Brachyelytrum erectum 257
Briza media 211
Bromus ciliatus 189
Bromus commutatus 188
Bromus Dudleyi 190
Bromus inermis 189

Page
Bromus mollis 187
Bromus racemosus 187
Bromus secalinus 188

Calamagrostis canadensis . . . 240
Calamagrostis cinnoides 241
Calamagrostis neglecta 241
Calamagrostis Pickeringii . . . 242
Cinna latifolia 251
Cynosurus cristatus 214

Dactylis glomerata 213
Danthonia compressa 237
Danthonia spicata 236
Deschampsia caespitosa 232
Deschampsia flexuosa 232
Digitaria Ischaemum 272
Digitaria sanguinalis 271
Distichlis spicata 213

Echinochloa crusgalli 282
Elymus mollis 223
Elymus virginicus 223
Eragrostis cilianensis 211

Page
Festuca capillata 192
Festuca elatior 191
Festuca obtusa 192
Festuca ovina 194
Festuca rubra 193

Glyceria borealis 199
Glyceria canadensis 201
Glyceria Fernaldii 203
Glyceria fluitans 199
Glyceria grandis 202
Glyceria melicaria 200
Glyceria obtusa 200
Glyceria pallida 203
Glyceria striata 201

Hierochloê odorata 264
Holcus lanatus 235
Hordeum jubatum 226
Hordeum montanense 226
Hordeum vulgare 225
Hystrix patula 225

Leersia oryzoides 268
Lolium perenne 226

Milium effusum 258
Molinia caerulea 212
Muhlenbergia foliosa 256
Muhlenbergia racemosa 256
Muhlenbergia uniflora 255

Nardus stricta 227

Oryzopsis asperifolia 259
Oryzopsis canadensis 260
Oryzopsis pungens 259

Panicum boreale 276
Panicum capillare 280
Panicum clandestinum 278
Panicum depauperatum 275
Panicum dichotomiflorum . . . 279
Panicum lanuginosum 277
Panicum linearifolium 276

Page
Panicum longifolium 281
Panicum meridionale 277
Panicum miliaceum 280
Panicum philadelphicum 279
Panicum spretum 276
Panicum subvillosum 278
Panicum virgatum 280
Phalaris arundinacea 267
Phalaris canariensis 266
Phleum pratense 254
Phragmites communis 215
Poa alsodes 208
Poa annua 205
Poa compressa 206
Poa costata 207
Poa nemoralis 209
Poa palustris 209
Poa pratensis 206
Poa saltuensis 208
Poa trivialis 208
Puccinellia distans 196
Puccinellia fasciculata 196
Puccinellia maritima 196
Puccinellia pumila 196

Schizachne purpurascens 216
Secale cereale 222
Setaria italica 285
Setaria lutescens 284
Setaria viridis 284
Sieglingia decumbens 238
Spartina alterniflora 262
Spartina patens 263
Spartina pectinata 261
Sphenopholis intermedia 229
Sporobolus vaginaeflorus 256

Trisetum flavescens 231
Trisetum spicatum 230
Triticum aestivum 222
Zea Mays 286
Zizania aquatica 270

PRESIDENTIAL ADDRESS

R. J. Bean

(Read October 13, 1941)

Approximately seventy nine years ago this Institute closed its first annual session and opened the second. From the beginning it has been a regular procedure for the president to give a review of the work of the session and express his own views as to the past, present, and future policies of the Institute. It has also been the custom to include brief obituaries for members who have died during the session.

On December 30th., 1940, members of the Institute were profoundly shocked to learn of the sudden and totally unexpected death of Dean Carleton Bell Nickerson. Dean Nickerson was born at Boothbay Harbor, Maine, U.S.A., in the year 1885. He received his M.A. at Clarke University in 1907. After three years of service on the staff of Clarke University he came to Dalhousie in 1910 as an instructor in chemistry. In 1923 he was appointed head of the Department of Chemistry, and in 1936 he became Dean of the Faculty of Arts and Sciences at Dalhousie University. Professor Nickerson became a member of this society in 1911 and was president from 1922-24. During a period of nearly thirty years he gave hearty support to the Institute and a majority of his publications are to be found in the Proceedings of this society.

The death of William Francis Ganong, aged 77, at St. John, New Brunswick, on September 7th., 1941, removed from our mailing list one of the oldest if not the senior living member of the Institute. Born at St. John, New Brunswick, in 1864, Dr. Ganong received his M.A. in 1886 from the University of New Brunswick, and one year later the A.B. degree from Harvard. He was awarded a Ph.D. from Munich in 1894 and subsequently had two honary degrees conferred upon him at the University of New Brunswick. Except for a few years teaching at Harvard his entire academic career was spent at Smith College, Southampton, Massachusetts. There, he not only built the famous Botanic Gardens and the Lyman Plant

House, but also acquired an international reputation as a teacher and investigator in practically every field of botany. While most of the world knew Ganong primarily as a botanist, his native province knew him best as an authority on the natural history, geology, Indian lore and the early settlements of New Brunswick. Dr. Ganong became a corresponding member of the Institute January 6th., 1890.

At the first council meeting of the present session, some doubts were expressed that there would be enough papers offered to provide a full programme for as many as five or six ordinary meetings. Fortunately it was possible to hold eight meetings, the last of which was convened on September 26th., thereby creating a record for the number of meetings and extension of the active session which has not been equalled for many years. A review of papers read and demonstrations given may be summarized as follows:

Subject	
Biochemistry	9
Bacteriology	3
Physiology	2
Botany	2
Zoology	2
Mining	2
Demonstrations	2
Fisheries	1

Source	
Biochemistry	9
Fisheries	5
Physiology	4
Biology	3
Dept. Mines	2

The average attendance was twenty four which is good for a society no larger than ours. The peak attendance was reached when fifty one persons including members of the Institute and invited guests, assembled at the extraordinary meeting called on September 26th., to hear a masterly address on "Some Recent Aspects of Genetics", delivered by Professor R. Ruggles Gates, F.R.S., Kings College, University of London and a corresponding member of the Institute since 1916. The discussion which followed was, to many, no less interesting than the address. The meeting was made more enjoyable through the courtesy of Dr. W. W. Woodbury who made it possible for many members of the Institute to meet the guest speaker at the Woodbury home where Mrs. R. H. Woodbury acted as hostess.

For many years the number of papers presented for publication in the Proceedings has been small and the past session has been no exception. Nevertheless, one paper from the above classified list, Dr. Gates' address, and two other papers are sufficient to make an excellent number. The problem of getting papers for publication in the Proceedings is possibly more acute now than at any time over a period of years. Both the editor and the council have long realized certain obvious reasons for this situation. The circumstances of the war have added new difficulties. We had no papers in either physics or chemistry during the present session, and we have little hope that there will be any offered in physics at least, for the duration. All publications in fisheries have been restricted, and some of our former contributors in this field are serving with the armed forces of the Dominion while others have either been transferred or left the employ of the Fisheries Research Board. Added to these facts it is well to note that our membership is steadily decreasing. There were no requests for financial assistance by our out-of-town members to present papers at our meetings, although the council took special action in the case of Dr. Gates. Possibly the problem is no more serious than it was a year ago, but it is one which the council will have to bear constantly in mind during the next session.

Two innovations were tried out at our meetings this session, one, the serving of refreshments after adjournment, the other, setting the time of our ordinary meetings at 8.15 p.m. Continuation of either of these customs rests with the will of the council and members of the Institute as a whole.

The library has suffered a great decrease in the exchange list, a condition due in part to the war. D. K. Crowdis has been appointed Curator of the Provinical Museum, but is not librarian. Under existing conditions the council has asked Dr. Ernest Hess to act as librarian for the Institute until some more definite arrangements can be made.

The Institute is about to begin its eightieth session. No one can say what the future will bring. Already individual members have been called to war duties. In the immediate future we may expect to carry on as usual, but, should the call come for institutions similar to our own to assist in the war effort as organizations, there should be but one answer. Let us then be prepared to give the most efficient collaboration possible, if the need arises.

A year ago you conferred upon me a great honor by electing me as President of the Nova Scotian Institute of Science. Taking the chair vacated by Dr. King, I sincerely asked for your co-operation. May I say at this time that I have never experienced anything like the wide degree of co-operation you have given.

PROCEEDINGS OF MEETINGS

SESSION OF 1941-42

(All meetings were held in the Medical Science Building, Halifax)

80*th Annual Business Meeting*, October 13, 1941.

The President, Professor R. J. Bean read the annual address. This is printed in full.

The Treasurer's report is summarized as follows:

Receipts	$ 789.31
Expenditures	1,263.90
Assets—Current Account, Cash and Bank	1,024.51
Permanent Fund, Trustee Bonds	4,500.00

The Corresponding Secretary was not present.

The Editor reported that the 1940-1941 Proceedings was nearly ready for distribution. It contains four scientific papers, two of which have been read before the Institute.

The Librarian reported for the two years, December 1, 1938 to November 30, 1940. Accessions to the library are showing a serious decline, having dropped to less than half of the decade average of 2,659 books and pamphlets. This trend has been evident since 1935 but has been greatly accelerated because of war conditions. Borrowings from the library show a remarkable increase, having more than doubled the decade average of 1,281 but most of the increase is of text books and is not from the Institute section of the Provincial Science Library. Some 160 volumes have been bound; the publications of the following societies are now bound up to date, *Royal Society of London*, *Royal Society of Arts*, *Society of Chemistry and Industry*, *Geological Society* (*London*), *Society of Electrical Engineers* (*London*), *Royal Microscopical Society*, *American Academy of Science*, *American Philosophical Society*, *National Academy of Science*, *Geological Survey of Canada*, *Royal Canadian Institute*, *Fisheries Research Board of Canada* and *Bergen's Museum*.

Officers elected for the year 1941-1942 were:

President.....................Professor R. J. Bean
1st Vice President.............Dr. E. Hess
2nd Vice President............Dr. F. R. Hayes
Treasurer.....................Professor W. P. Copp
Corresponding Secretary........Dr. M. K. McPhail
Recording Secretary............Dr. C. B. Weld
Council.......................Dr. D. L. Cooper, Dr. R. D. H. Heard, Dr. A. E. Cameron, Dr. H. P. Bell, Dr. E. P. Linton.
Editor........................Dr. E. Hess
Librarian.....................Dr. F. R. Hayes
Institute Nominations to Provincial Science Library Commission—Dr. E. Hess and Dr. F. R. Hayes.
Auditors......................Dr. H. L. Bronson and P. R. Colpitt, Esq.

In the general discussion which followed, the need for reduction of expenses was brought to the attention of council. As the cost of the current number of the Proceedings alone will be considerably greater than the entire ordinary income of the Institute, it is evident that were it not for the government grant, a considerable curtailment of the activities of the Institute would be necessary. It was decided that the serving of refreshments at the Ordinary Meetings had not stimulated membership or discussion and that experiment be discontinued.

There was discussion concerning the status and powers of the Provincial Science Librarian but the suggestion that the government be asked to appoint someone with authority was not acted upon. It was thought that the time was not opportune and that action should be postponed for the duration of the war.

Extraordinary Meeting—October 23, 1941.

Dr. H. H. Brown, Director of the Sponge Fisheries Investigation of the Bahamas, spoke on "The Sponge Fisheries of the West Indies." Attendance was good and there was much discussion. An abstract of the paper is printed in the Proceedings.

1*st Ordinary Meeting*, November 10, 1941.

The following new members were announced (elected by Council October 27, 1941): Ordinary, Dr. E. S. Bean; student membership, George B. Rosenfeld, Douglas Darcy, Charlotte Sullivan, Irene Pentz, George E. Mack and W. Hawkins.

Papers: "The Ferns of Nova Scotia," by A. E. Roland; "Potassium Chloride Haemolysis," by Hugh Davson; "On the Carbohydrate Metabolism of Certain Bacteria causing Decomposition of Fish," by G. J. Sigurdsson.

2*nd Ordinary Meeting*, December 8, 1941.

Papers: "The Metabolism of the Corpus Luteum Hormone, Progesterone," by R. D. H. Heard and M. M. Hoffman; "The Phosphorus Content of Lobster Blood and Muscle," by A. Hollett; "Observations on Sterile Cod Livers," by W. W. Johnston and A. J. Wood.

3*rd Ordinary Meeting*, January 19, 1942.

T. K. Bentley, Esq., was announced as new student member (elected January 5, 1942).

Papers: "Food Preferences and Consumption of Families with Low Incomes in Halifax, N. S.," by E. G. Young, "Penetration of Sugars into the Aqueous Humour of the Eye," by C. B. Weld and W. H. Feindel, "Steroids X. The Metabolism of Ovarian Follicular Hormone," by W. S. Bauld and R. D. H. Heard.

4*th Ordinary Meeting*, February 16, 1942.

Dr. C. J. Kerswill and Dr. J. C. Medcof were announced as new associate members (elected February 2nd).

Papers: "Steroids XI. The Isolation of a Water Soluble, Ether Insoluble Estrogen from the Urine of Estradiol-Injected

Rabbits," by W. S. Bauld, R. D. H. Heard and M. M. Hoffman; "Putty Spoilage of Salt Fish," by W. J. Dyer; "The Origin and Histology of Bordeaux Spray Russeting on the Apple," by Hugh P. Bell. Demonstration—"Pitch Discrimination in Man," by C. B. Weld.

5th Ordinary Meeting, March 16, 1942.

Miss Elizabeth Baird was announced as a new student member (elected March 2, 1942).

Papers: "The Mouse Adrenal Gland I. Observations on Early Development, Degeneration and Regeneration of the X-Zone," by M. K. McPhail and H. C. Read; "A Form of Membrane Catalysis," by Hugh Davson. Demonstration—"The Ainsley Micro Balance;" by R. D. H. Heard.

6th Ordinary Meeting, April 13, 1942.

Papers: "The Relative Rate of Reduction of Trimethylamine Oxide and Sodium Nitrate by Certain Fresh Fish Spoilage Bacteria," by G. J. Sigurdsson, W. J. Dyer and A. J. Wood; "Studies on the Mouse Adrenal II. The Sensitivity of the X-Zone to Various Hormonal Substances," by M. K. McPhail and H. C. Read. Demonstration—"An Invention for Motor Cars for the Saving of Gasoline, Oil and Brake Lining," by G. A. Sandoz.

C. B. Weld
Recording Secretary

ABSTRACTS

(Papers read before the Institute but not published in the Proceedings)

THE SPONGE FISHERIES OF THE WEST INDIES. H. H. Brown, Director of the Sponge Fisheries Investigation of the Bahamas. (Read October 23, 1941). The Sponge Fisheries, the main staple industry of the Bahamas had progressively fallen from a £150,000 to a £60,000 annual business. The oceanographic and biologic investigations undertaken are described. Sponge culture methods and relief from overfishing seemed to be well on the way to improve the industry when a sudden, quite unexpected, fungus epidemic destroyed some 90% of the sponges not only of the Bahamas but also of Cuba, the Honduras, and to a less extent of Florida. It will be many years before the few remaining, resistant sponges, can multiply to commercial numbers.

POTASSIUM CHLORIDE HAEMOLYSIS. H. Davson, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read November 10, 1941). The haemolysis of the dog erythrocyte in isotonic solutions of potassium salts has been investigated to see whether the destructive action of the salts is a chemical effect on the cell membrane similar to that of other haemolytic agents such as saponin, or whether it is due to the osmosis of water into the cell following the penetration of potassium. An excellent correlation between the permeability of the cells to potassium and the rate of haemolysis in different solutions of potassium salts suggested that the latter hypothesis was correct. It was shown, however, that although potassium enters the cells, sodium leaves them at about the same rate so that the postulated osmotic pressure difference required to cause haemolysis is apparently not established. This contradiction was resolved by showing that in potassium chloride solution the cells fall into two classes; about half of which are virtually impermeable to sodium but permeable to potassium, and it is these cells which haemolyse in potassium chloride solution; the remaining half is permeable to potassium and impermeable to sodium, and hence these cells shrink and therefore do not haemolyse. Thus, although the average osmotic pressure of the cell contents remains unchanged, half the cells undergo an increase in this osmotic pressure sufficient to cause haemolysis, whilst the remaining half show a corresponding decrease.

The division of the cells into these two classes is brought about by the following circumstances: swelling of the cells causes them to become impermeable to sodium; shrinking of the cells causes them to become impermeable to potassium. (Submitted for publication in full to Am. J. Physiol.).

ON THE CARBOHYDRATE METABOLISM OF CERTAIN BACTERIA CAUSING DECOMPOSITION OF FISH. G. J. Sigurdsson, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read November 10, 1941). The fermentation of glucose and lactate by "resting" cells of trimethylamine oxide reducing bacteria has been studied. The principal products of glucose fermentation are in general lactic acid, acetic acid, formic acid, ethyl alcohol and carbon dioxide. The proportons of these vary, and sometimes carbon dioxide is absent. Most of the cultures produce small amounts of acetyl-methyl carbinol from glucose. Much more lactic acid is produced when the reaction of the medium is acid, and there is a corresponding variation in the other products.

The chief metabolic product of lactate is carbon dioxide, but in a few cases some acetic or formic acid is also formed. 2.6 to 5.8 millimoles of trimethylamine oxide are reduced for every millimole of lactate fermented. In the fermentation of glucose reduction of the oxide is much less. (Published in full in J. Fish. Res. Board Canada, **VI**:(1). 1942).

STEROIDS IX. THE METABOLISM OF THE CORPUS LUTEUM HORMONE, PROGESTERONE. R. D. H. Heard and M. M. Hoffman, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read December 8, 1941). To gain insight into the course of metabolism of progesterone, a chemical study has been made of the fate in the rabbit of this luteoid, administered alone and concomitantly with the ovarian follicular hormone, L-estradiol. (Submitted for publication in full to J. Biol. Chem.)

THE PHOSPHORUS CONTENT OF LOBSTER BLOOD AND MUSCLE. A. Hollett, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read December 8, 1941). Estimates of inorganic and organic phosphorus were made on the blood and muscle of lobster during the pre-molt, inter-molt and post-molt periods. The concentration of phosphorus in the blood was highest immediately preceding the molt, and lowest following it. No corresponding changes were observed in the phosphorus content of the muscle.

OBSERVATIONS ON STERILE COD LIVERS. W. W. Johnston and A. J. Wood, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read December 8, 1941). The slow development of free fatty acids in the oil from sterile cod livers has been observed. In the absence of bacteria the origin of these fatty acids must be sought in enzymatic activity. Any agent devised to suppress the development of free fatty acid in cod livers must combine the qualities of an enzyme paralytic and a bactericide.

FOOD PREFERENCES AND CONSUMPTION OF FAMILIES WITH LOW INCOMES IN HALIFAX, N. S. E. G. Young, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read January 19, 1942). The data obtained in the dietary survey of the Canadian Council of Nutrition carried out in Halifax in 1939-40 have been re-examined to determine the consumption per person per week of the most important foodstuffs as purchased. These results have been compared with similar data available from studies in The United States and Great Britain and in relation to total income and food expenditure. The consumption of butter, eggs, milk, cheese, fish and meat were most notably contracted by falling expenditure. Bread and potatoes were independent and relatively constant. Other dietary items with the exception of sugar did not show a consistent relationship. (Published in full in Can. Pub. Health Journal **33**: (10): 180-5. 1942).

THE PENETRATION OF SUGARS INTO THE AQUEOUS HUMOUR OF THE EYE. C. B. Weld and W. H. Feindel, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read January 19, 1942). In a study of the permeability of the membranes separating the aqueous humour of the eye from the blood, xylose, glucose, sucrose, and raffinose were injected intravenously into dogs to maintain the blood sugar level at two or three times the normal value. The sugars were determined by the Hagedorn and Jensen method on specimens of aqueous and blood taken before and at a desired time after injection. Raffinose and sucrose were determined by taking the difference between the reducing values of the hydrolyzed and non-hydrolyzed samples. When the ratios of the increase of the concentration of a sugar in aqueous humour to the increase in serum are plotted against the time, the resulting curves indicate that the initial time of penetration and the subsequent increase of the four sugars in the aqueous humour are inversely related to their molecular size.

Xylose showed the most rapid rate of penetration with an increase in the concentration ratio of 25% at three minutes. Glucose, reaching a value of 25% at ten minutes, was slightly slower. Sucrose gave a value of 6% for the concentration ratio at thirty minutes, and over a period of six hours rose to no higher than 35%. Raffinose showed the slowest rate of penetration with a possible increase of 2% (within the limit of the experimental error) at one hour and of 4% at the end of three hours, hence representing about the limit of the size of molecule able to pass through the blood-aqueous membranes.

The relative impermeability of the blood-aqueous barrier to raffinose, with a molecular weight of 504, provides a structural basis for the validation of some secretory activity being imposed upon the primary process of filtration in the formation of the aqueous humour, since the intercellular pores are indicated to be of sufficiently small size to prevent back-diffusion of the secreted substances. (Published in full in Am. J. Physiol., (in press)).

STEROIDS X. THE METABOLISM OF THE OVARIAN FOLLICULAR HORMONE. W. S. Bauld and R. D. H. Heard, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read January 19, 1942). Based on biological and colorimetric assays of the "weakly" and "strongly" phenolic fractions of the urine of normal and hysterectomized rabbits and women, Pincus, and Smith and Smith have elaborated the widely accepted hypothesis that the conversion of the follicular hormone, α-estradiol, to the urinary excretory product, estriol, takes place in the uterus under the influence of progesterone.

To test the hypothesis, a study has been made of the fate in the normal and hysterectomized rabbit of α-estradiol, administered alone and concomitantly with progesterone. In all cases, β-estradiol and estrone were found to be the main excretory products, which occur in the proportion of 4-5 to 1. Thorough exploration of the urine by systematic fractionation and chromotographic analysis failed to reveal the presence of estriol. That the conditions of processing of the urine permit of the isolation of estriol was shown by the recovery of 29.6 mg. after injection of 300 mg. The question of the metabolism of the estrogens is discussed in the light of this confliction of clinical and chemical findings. (Submitted for publication in full to J. Biol. Chem.)

STEROIDS XI. THE ISOLATION OF A WATER SOLUBLE, ETHER INSOLUBLE CONJUGATED ESTROGEN FROM THE URINE OF α-ESTRADIOL-INJECTED RABBITS. W. S. Bauld, R. D. H. Heard, and M. M. Hoffman, Dept. of Biochemistry, Dalhousie University, Halifax, N. S. (Read February 16, 1942). In part IX of this series, it was demonstrated that, in the rabbit as in the human, pregnane-3(α), 20(α)-diol represents the urinary excretory product of the corpus luteum hormone progesterone.

In an effort to ascertain the nature of conjugated pregnanediol excreted, the Venning and Browne procedure for the isolation of sodium pregnanediol glucuronidate was applied to the urine of adult estrous rabbits receiving α-estradiol and progesterone. No pregnanediol glucuronide was obtained, but rather a water soluble, combined estrogen.

The conjugate, m.p. 270°, C-56.8%, H-7.27%, was non-phenolic but gave all colour reactions characteristic of β-estradiol. It failed to reduce Benedict's solution, and to exhibit the naphthoresorcinol test for glucuronides; the presence of sodium and the absence of nitrogen, sulphur and phosphorus was established. On acid hydrolysis, a reducing sugar which showed a positive naphothoresorcinol reaction was set free together with the steroid moiety, m.p. 223°, which proved to be non-phenolic. It is therefore tentatively suggested that the conjugate is the sodium salt of a 3-ether of β-estradiol-17-glycuronide. (Submitted for publication in full to J. Biol. Chem.)

"Putty" Spoilage of Salt Fish. W. J. Dyer, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read February 16, 1942). It has been shown that this type of spoilage is the result of holding fish at high temperatures for a time sufficient to allow penetration of bacteria into the deep tissues. These bacteria initiate decay before the salt reaches that area in a concentration high enough to stop bacterial action.

The Origin and Histology of Bordeaux Spray Russeting on the Apple. Hugh P. Bell, Dept. of Biology, Dalhousie University, Halifax, N. S. (Read February 16, 1942). Apple trees of the McIntosh Red variety were sprayed at about the time of full bloom in 1939 and 1940. The origin and structure of the resultant russet tissue is described. The first apparent injury is a browning of the epidermal cells at the base of the hairs. The growth of these browned cells is inhibited and, owing to this, cracks occur as the fruit enlarges. Adjacent hypodermal and cortical tissue is exposed and killed. Cork cambiums and cork are formed in the cortex. This cork is different in origin from normal russet cork, which originates in the epidermis. The further enlargement of the fruit causes the cracks to multiply, extend tangentially, and deepen. All tissues external to the innermost point of fissure penetration become killed. The final scurf-like patches of scar tissue are a mixture of dead epidermis, hypodermis, cortex, cork, and cork cambiums. This scar tissue is not true cork. (Published in full in Can. J. Research, C, 9: 493-499. 1941).

The Mouse Adrenal Gland I. Observations on Early Development, Degeneration and Regeneration of the X-zone. M. K. McPhail and H. C. Read, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read March 18, 1942). A histological study of the late pre-natal and early post-natal life of the X-zone has been made. The effect of pregnancy and lactation on the involution of the zone has been examined as well as its regeneration following pregnancy. Regeneration of the gland following enucleation and transplantation has also been studied in the immature animal. (Submitted for publication in full to Anat. Record).

A Form of Membrane Catalysis. Hugh Davson, Dept. of Physiology, Dalhousie University, Halifax, N. S. (Read March 18, 1942).

The erythrocyte of the cat is permeable to both sodium and potassium; in accordance with the general theory of permeability of lipoid membranes the permeability of the cell membrane to sodium should be less than that to potassium; however this is not the case in the present instance since the membrane permeability to sodium is on the average five times greater than that to potassium. Moreover it has been found that the effects of a large number of environmental influences on permeability are markedly different according as sodium or potassium permeability is being studied; thus narcotics inhibit sodium permeability but accelerate potassium permeability. The clue to the interpretation of these findings is given by the effects of pH and temperature on the two permeability processes; it is found that sodium permeability is optimal over the physiological pH and temperature ranges (pH 7.4-7.6 and 35-40° C.), whereas potassium permeability shows no such phenomenon. It is concluded that there is present in the membrane an enzyme-like factor which reduces the activation energy necessary for a sodium ion to possess before it can penetrate the membrane; this factor is apparently specific for sodium so that the penetration of potassium is not catalysed and is therefore much slower than that of sodium.

THE RELATIVE RATE OF REDUCTION OF TRIMETHYLAMINE OXIDE AND SODIUM NITRATE BY CERTAIN FRESH FISH SPOILAGE BACTERIA. G. J. Sigurdsson, W. J. Dyer and A. J. Wood, Atlantic Fisheries Experimental Station, Halifax, N. S. (Read April 13, 1942). Trimethylamine oxide and the nitrate ion are both activated by certain bacteria as hydrogen acceptors with consequent reduction to trimethylamine and to nitrite. It has been found, that with certain bacteria, when both compounds are present in the growth medium, the nitrate is reduced without any measurable activation of the trimethylamine oxide despite the fact that the same cultures are known to activate both compounds when they occur singly in the substratum. With other cultures the opposite is true. That is, the trimethylamine oxide is reduced without activation of the nitrate. This sparing action of one compound on the reduction of the other is difficult to interpret on the basis of the normal concept of oxido-reduction. (Submitted for publication in full to J. Fish. Res. Bd. Can.)

THE MOUSE ADRENAL GLAND II. SENSITIVITY OF THE X-ZONE TO VARIOUS HORMONAL SUBSTANCES. M. K. McPhail and H. C. Read, Dept. of Pharmacology, Dalhousie University, Halifax, N. S. (Read April 13, 1942). A.P.L. and P.M.S. hormones caused degeneration of the X-zone of the adrenal gland in intact immature male and female mice. That they act via the gonads is shown by their complete inactivity in the castrate. Similar results were obtained with urine of pregnancy (human). A.P.L. in the few tests made, caused degeneration of the X-zone in adult females.

Oestrone administration in the immature male and female was followed by a disappearance of the X-zone. In the adult female it produced a ring of degeneration in the cortex between the X-zone and the zona fasiculata, the latter being predominately involved. In the adult male the ring of degeneration borders the medulla (the X-zone being absent). Administration of progesterone and desoxycorticosterone acetate were without effect. Gradual regeneration of the X-zone occurred following its destruction by A.P.L. and testosterone propionate. (Submitted for publication in full to Anat. Record).

INDEX

Volume XX

Ascorbic Acid Content of Some Maritime Foods. B. C. Collier, M. F. M. Morrison and M. E. Morse 121

Barytes Deposit at Pembroke, N. S. A. E. Cameron 57

Cameron, A. E. Barytes Deposit at Pembroke, N. S. 57
Collier, B. C., M. F. M. Morrison and M. E. Morse. The Ascorbic Acid Content of Some Maritime Foods 121

Dore, W. G. and A. E. Roland. The Grasses of Nova Scotia 177

Ferns of Nova Scotia. A. E. Roland 64
Fishes of Malpeque Bay. A. W. H. Needler 33

Gates, R. R. Some Recent Aspects of Genetics 127
Genetics, Some Recent Aspects of. R. R. Gates 127
Grasses of Nova Scotia. Dore, W. G. and A. E. Roland 177

Marine Fish and Salp Records. R. A. McKenzie 13
Marine Records from Nova Scotian Fishing Waters. R. A. McKenzie 42
McKenzie, R. A. Some Marine Fish and Salp Records 13
McKenzie, R. A. Some Marine Records from Nova Scotian Fishing Waters 42
Morrison, M. F. M., see Collier, B. C. 121
Morse, M. E., see Collier, B. C. 121

Needler, A. W. H. A Preliminary List of the Fishes of Malpeque Bay 33

Odonata of the Maritime Provinces, Additions to the List. E. M. Walker 159

Pneumothorax Gases. C. B. Weld 1
Presidential Addresses:
  1938. G. H. Henderson 21
  1939. Harold S. King 47
  1940. Harold S. King 141
  1941. R. J. Bean 289
Proceedings of Annual Business Meetings (Treasurer's Reports, Librarian's Reports, Officers Elected):
  1938 27   1940 149
  1939 50   1941 293
Proceedings of Ordinary and Extraordinary Meetings:
  1938-39 28   1940-41 150
  1939-40 51   1941-42 294

Roland, A. E. The Ferns of Nova Scotia 64
Roland, A. E., see also Dore, W. G. 177

Walker, E. M. Additions to the List of Odonata in the Maritime Provinces 159
Weld, C. B. Pneumothorax Gases 1

ABSTRACTS

Armstrong, F. H. The Growth Rate of Salmon Embryos 157
Arnell, J. C. and Coffin, C. C. Further Studies on the Decomposition of Ethylidene Diacetate Homologues 56

Bauld, W. S. and C. W. Small. The Synthesis of Substituted Phenanthrenes Related to the Steroids 154
Bauld, W. S. and R. D. H. Heard. Steroids X. The Metabolism of Ovarian Follicular Hormone 299
Bauld, W. S., R. D. H. Heard and M. M. Hoffman. Steroids XI. The Isolation of a Water Soluble, Ether Insoluble Conjugated Estrogen from the Urine of α- Estradiol-Injected Rabbits 299
Begg, R. The Inorganic Nutrient Requirements of *B. Coli Communis* 30
Bell, H. P. Calyx and Structure of the Gravenstein Apple 54
Bell, H. P. Winter Growth in the Vegetative Buds of the Wagener Apple 155
Bell, H. P. The Origin and Histology of Bordeaux Spray Russeting on the Apple 300
Brown, H. H. The Sponge Fisheries of the West Indies 297

Coffin, C. C. A New Type of Calorimeter 31
Coffin, C. C., see Arnell, J. C. 56
Collins, V. K. A Study of Fish Spoilage 30
Collins, V. K. The Production of Dimethylamine in Cod Muscle Press Juice During Spoilage 55

Davson, H. and J. P. Quillam. Permeability of the Eye Membrane. 54
Davson, H. and E. Ponder. Photo-Dynamic Haemolysis 55
Davson, H. The Effect of Fluoride on the Permeability of the Red Blood Cell 154
Davson, H. and C. B. Weld. Studies on Aqueous Humour 155
Davson, H. Potassium Chloride Haemolysis 297
Davson, H. A Form of Membrane Catalysis 300
Dyer, W. J. Phytin as an Organic Constituent of Soil 154
Dyer, W. J. "Putty" Spoilage of Salt Fish 300
Dyer, W. J., see Sigurdsson, G. J. 301

Edson, M. and R. D. H. Heard. Hydrolysis of the Conjugated Oestrogens of Mare's Pregnancy Urine 31
Elliot, L. G. An Adiabatic Calorimeter for Determining Heat Capacities of Metals from 100°C. to 200°C. 56

Feindel, W. H. Somatic Chromosomes in *Vicia Faba* L. 155
Feindel, W. H., see also C. B. Weld 298
Frank, M. and E. Hess. Survival of *Eb. typhosa* and *Es. coli* on Salt Fish 153
Frank, M. and E. Hess. Studies on Brown Halophilic Molds of the Genus *Sporendonema* emend. Ciferri et Redaelli 155

Hayes, F. R. The Hatching Mechanism of Salmon Eggs 157
Hayes, F. R., see also Johnstone, J. H. L. 31
Heard, R. D. H. The Synthesis of d:1-β-3:4-Dihydroxyphenyl-N-Methylalanine 30
Heard, R. D. H. and A. F. McKay. The Isolation of a New Androstanol-3(β)-One and of Allo-Pregnanol-3(β)-One-20 from the Urine of Pregnant Mares 53
Heard, R. D. H. The Oestrus-Inducing Gonadotrophic Substance. II. A Comparison of the Infantile and Adult Rat Assays 54
Heard, R. D. H. and M. M. Hoffman. Steroids III. Observations on the Constitution of a New Keto-Lactone from the Urine of Pregnant Mares 55
Heard, R. D. H. and M. M. Hoffman. Steroids IV. The Isolation from Equine Pregnancy Urine and Characterization of a New Member of the Female Sex Hormone Series 153
Heard, R. D. H. and A. F. McKay. Steroids V. The Kishner-Wolff Reduction of Dehydro-Iso-Androsterone 153
Heard, R. D. H. and A. F. McKay. Steroids VI. Observations on the Constitution of Androstanol-3(β)-One from Equine Pregnancy Urine 156
Heard, R. D. H. and A. F. McKay. Steroids VII. The Synthesis of Androstanol-3(β)-One-7 156
Heard, R. D. H. and M. M. Hoffman. Steroids VIII. The Conversion of Estradiol to Estrone in Man 156
Heard, R. D. H. and M. M. Hoffman. Steroids IX. The Metabolism of the Corpus Luteal Hormone, Progesterone 298
Heard, R. D. H., see also Edson, M. 31
Heard, R. D. H., see also Bauld, W. S. 299
Hess, E., see Frank, M. 155
Hoffman, M. M., see Heard, R. D. H.
Hoffman, M. M., see also Bauld, W. S. 299

Hollett, A. The Carbohydrate Metabolism of Developing Salmon Eggs 53
Hollett, A. The Phosphorus Content of Lobster Blood and Muscle 298

Johnston, W. W. An Undescribed Compound of Histidine 30
Johnston, W. W. Fish Enzymes as Leather Bates 54
Johnston, W. W. and A. J. Wood. Observations on Sterile Cod Livers 298
Johnstone, J. H. L. and F. R. Hayes. The Ultra-Violet Absorption Spectrum of Salmon Egg Oil 31

McKay, A. F., see R. D. H. Heard.
McKenzie, R. A. Canadian Atlantic Cod Migrations 31
McKenzie, R. A. Eastern Canadian Flat Fishes 54
McPhail, M. K. and H. C. Read. The Mouse Adrenal Gland I. Observations on Early Development, Degeneration and Regeneration of the X-Zone 300
McPhail, M. K. and H. C. Read. The Mouse Adrenal Gland II. The Sensitivity of the X-Zone to Various Hormonal Substances 301

Ponder, E., see Davson, H 55

Quillam, J. P., see Davson, H 54

Read, H. C., see McPhail, M. K 300

Sigurdsson, G. J. On the Carbohydrate Metabolism of Certain Bacteria Causing Decomposition of Fish 297
Sigurdsson, G. J., W. J. Dyer and A. J. Wood. The Relative Rate of Reduction of Trimethylamine Oxide and Sodium Nitrate by Certain Fresh Fish Spoilage Bacteria 301
Small, C. W., see Bauld, W. S 154

Weld, C. B. Photometric Measurements with the Ordinary Colorimeter: Hemoglobin Determinations 30
Weld, C. B. The Capillary Resistance Test 56
Weld, C. B., see also Davson, H 155
Weld, C. B. and W. H. Feindel. The Penetration of Sugars into the Aqueous Humour of the Eye 298
Wentworth, H. The Estimation of Allantoin in Blood 157
Wood, A. J., see Johnston, W. W 298
Wood, A. J., see also Sigurdsson, G. J 301
Young, E. G. The Ultra-Centrifugal and Electrophoretic Analysis of the Proteins of Egg White 30

Young, E. G. A Dietary Survey in Halifax 157
Young, E. G. Food Preferences and Consumption of Families with Low Incomes in Halifax, N. S 298

MCZ ERNST MAYR LIBRARY
3 2044 128 447 257